Wiadomości Lekarskie Medical Advances

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CONTENTS

ORIGINAL ARTICLES

| Aidyn G. Salmanov, Volodymyr V. Artyomenko, Andrii O. Shchedrov, Andrii P. Prishchepa, Svitlana M. Korniyenko, Andriy I. Chubaty, Igor V. Maidannyk, Olena O. Chorna, Victor O. Rud, Vitalii S. Strakhovetskyi, Mykhailo V. Knyhin, Anastasia S. Padchenko | |
|---|--------|
| Adverse pregnancy outcomes associated with endometriosis in Ukraine: results a multicenter study | 1113 🙆 |
| Olga V. Sheshukova, Tetiana V. Polishchuk, Valentyna P. Trufanova, Sofia S. Bauman, Kateryna S. Kazakova, Anna S. Mosiienko, Alina I.Maksyme Increasing the efficiency of dental disease prevention in children of younger school age through participation | nko |
| in a stomatological performance | 1122 🙋 |
| Oleksander Y. loffe, Victor O. Nevmerzhytskyi, Mykola S. Kryvopustov, Yurii P. Tsiura, Taras M.Galyga, Stepan L. Kindzer, Vladislav M. Perepadya Improving the management of morbidly obese patients with postoperative bleeding undergoing Roux-en-Y gastric bypass | 1127 💋 |
| Dwi Retnoningrum, Budi Mulyono, Umi Solekhah Intansari, Ardhea Jaludamascena | |
| Interleukin-17 as predictor mortality of septic patients: a systematic review and meta-analysis | 1134 🔼 |
| Ivan M. Okhrimenko, Igor V. Ozerskvi, Liudmyla V. Levytska, Natalia H. Ivanova, Yurii A. Ivanov | |
| The impact of negative factors of professional activities on the health of law enforcement officers | 1141 😰 |
| Tatiana () Timokhina | |
| Condition of oral tissues in children with congenital cleft lip and palate | 1147 🗖 |
| Olha V. Sheshukova, Anna S. Mosiienko, Tetiana V. Polishchuk, Valentina P. Trufanova, Sofiya S. Bauman, Kateryna S. Kazakova, Vadim I. Dodatko |) |
| Epidemiology of dental caries in internally displaced children during wartime in Ukraine | 1155 🙆 |
| Grygoriy P. Griban, Bogdan S. Semeniv, Oksana M. Alpatova, Viktoriia B. Bakuridze-Manina, Liliya M. Tomich, Mykhailo O. Oliinyk, Nataliia O. Kh | lus |
| Current state of students' health and factors as well as means of its improvement | 1161 🔼 |
| Valentyn V. Bondarenko, Iryna S. Markus, Valentyn M. Savchenko, Svitlana I. Herashchenko, Svitlana M. Khatuntseva, Inesa V. Sheremet, Natalia A. Lyakhova | |
| The effectiveness of physical therapy in the rehabilitation of patients after arthroscopy of the knee joint | 1167 🔼 |
| Olena O. Yevdokimova, Vadvm B. Kharchenko, Irvna V. Zhdanova, Oksana P. Liaska, Olena P. Makarova, Olena M. Mokhorieva, Yuliia V. Sarbiei | |
| Dynamics of components of physical and mental health of law enforcement officers during the period of martial law | 1174 😰 |
| Andrii A. Rebryna, Yevhen V. Bazhenkov, Anatolii A. Rebryna, Halyna A. Kolomoiets, Tetiana K. Bondar, Tetiana A. Malechko | |
| Applied value of modern fitness technologies in improving the health and physical development of students | 1181 🙋 |

| Tetiana V. Tarasiuk, Oleksandr Yu. loffe, Oleksandr M. Chukanov, Mykola S. Kryvopustov, Oleksandr P. Stetsenko | |
|--|--------|
| The use of botulinum toxin type a to prepare patients with large ventral hernias for laparoscopic hernioplasty: Our experience | 1100 |
| our experience | 1100 |
| Yurii V. Novytskyi, Zoia V. Syrovatko, Tetiana H. Kozlova, Anna Yu. Chekhovska, Oleksandr Ye. Salamakha, Vadym M. Mykhailenko, | |
| Oksana M. Chychenova | 1100 |
| Health-Improving effect of running for students of technical specialties | 1198 🔼 |
| Valery G. Arefiev, Olena V. Andrieieva, Oleksandr A. Arkhipov, Nataliia D. Mykhailova, Inna M. Liakhova, Ivan M. Okhrimenko, Lyudmila V. Moroz | 2 |
| Substantiation of the methodology for assessing the biological age of adolescents | 1205 🔼 |
| Grygoriy P. Griban, Olha S. Zablotska, Natalia A. Lyakhova, Iryna I. Shpak, Soslan G. Adyrkhaiev, Lyudmyla V. Adyrkhaieva, Pavlo P. Tkachenko | |
| Maintaining a healthy lifestyle by service members under martial law | 1211 🖉 |
| Katervna S. Dovhonola. Olha O. Nabochenko. Tetiana M. Kostenko. | |
| Teachers' assessment of the mental health of children with special educational needs during the war | 1217 🔼 |
| Ivan M. Okhrimenko, Olena Yu. Pop, Nataliia V. Hresa, Alla A. Shylina, Valentyna O. Tyurina, Oleksandr V. Bakanychev, Natalia A. Lyakhova | |
| Motivational and value-based attitude of law enforcement officers to motor activity as a factor of a healthy lifestyle | 1224 💋 |
| Vasyl V. Prontenko, Maksym V. Pidoprygora, Dmytro V. Shtanagei, Mykhailo I. Matviienko, Valentyn P. Golub, Mykola V. Bohovyk, | |
| Larysa M. Onishchuk | |
| The impact of strength loads on the health status and physical readiness of female cadets | 1230 🔼 |
| Grygoriy P. Griban, Vasyl V. Yahupov, Valentyna I. Svystun, Valentyna A. Filina, Oksana P. Kanishcheva, Viktoriia B. Bakuridze-Manina, | |
| Iryna S. Oliinyk | |
| Characteristics of 16-17-year-old young males' physical development in the process of judo club activities | 1237 🔼 |
| Oleksii V. Tymoshenko, Zhanna H. Domina, Valentyna H. Bilyk, Yurii P. Serhiienko, Oleksandr M. Lavrentiev, Nataliia A. Dakal, Petro S. Horhol | |
| Health-promoting effect for students from physical loads of speed and strength orientation | 1243 💋 |
| Kostiantyn V. Prontenko, Stanislav O. Yuriev, Yurii G. Babaiev, Oleh O. Zimnikov, Taras H. Shchur, Oleh O. Abramenko, Oleksandr Yu. Borzilo | |
| Dynamics of health and physical development indicators of cadets during their professional training | |
| in the field environment | 1249 🔼 |
| Ivan M. Okhrimenko, Olga G. Marchenko, Olena Yu. Sashurina, Olha M. Pasko, Liudmyla M. Prudka, Tetyana V. Matiienko, Inha A. Serednytska | |
| Professional health of instructor-officers with different service experience | 1256 🔼 |

REVIEW ARTICLE S

| Andrii Skrypnyk, Tarana Aliieva, Ivan Titko | |
|--|----------|
| The use of specialized (medical) knowledge in the criminal process: the practice of the European Court of Human Rights | 1263 😰 |
| Piotr Kucharczyk, Karolina Anna Parzęcka, Michał Jakub Symulewicz, Weronika Zań, Kinga Szczepanik, Olaf Domaradzki, | |
| Bartłomiej Kusy, Mateusz Michalak, Marta Stolińska | |
| Innovative therapeutic strategies in the treatment of gastroesophageal reflux disease (GERD): A review of progress | |
| and perspectives | 1271 😰 |
| Bartłomiej Kusy, Karolina Parzecka, Piotr Kucharczyk, Kinga Szczepanik | |
| Long-chain polyunsaturated fatty acids and brain functions – literature review | 1277 😰 |
| Katarzyna-Elżbieta Grudnik, Maciej Słomian, Małgorzata Grudnik, Monika Prokurat, Mateusz Jagielski, Mateusz Migas, Karolina Lau, Janusz Ka | sperczyk |
| New solutions in transplantology and graft acquisition | 1284 🔼 |
| SHORT COMMUNICATION | |
| Agnieszka Rolek, Piotr Pławecki | |
| Surgical methods of managing the upper lip frenulum – a literature review | 1291 😰 |

ORIGINAL ARTICLE

CONTENTS 🔼

Adverse pregnancy outcomes associated with endometriosis in Ukraine: results a multicenter study

Aidyn G. Salmanov^{1,2}, Volodymyr V. Artyomenko³, Andrii O. Shchedrov⁴, Andrii P. Prishchepa⁵, Svitlana M. Korniyenko³, Andriy I. Chubatyy⁶, Igor V. Maidannyk⁶, Olena O. Chorna⁶, Victor O. Rud⁷, Vitalii S. Strakhovetskyi⁸, Mykhailo V. Knyhin⁸, Anastasia S. Padchenko⁹ ¹SHUPYK NATIONAL HEALTHCARE UNIVERSITY OF UKRAINE, KYIV, UKRAINE ²INSTITUTE OF PEDIATRICS, OBSTETRICS AND GYNECOLOGY OF THE NATIONAL ACADEMY OF MEDICAL SCIENCES OF UKRAINE, KYIV, UKRAINE ³ODESA NATIONAL MEDICAL UNIVERSITY, ODESA, UKRAINE ⁴SCHOOL OF MEDICINE OF V. N. KARAZIN KHARKIV NATIONAL UNIVERSITY, KHARKIV, UKRAINE ⁵KYIV CITY MATERNITY HOSPITAL NO3, KYIV, UKRAINE ⁶BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE ⁷NATIONAL PIROGOV MEMORIAL MEDICAL UNIVERSITY, VINNYTSIA, UKRAINE ⁸MEDICAL CENTRE "ASHERA", KHARKIV, UKRAINE ⁸KYIV PERINATAL CENTER, KYIV, UKRAINE

ABSTRACT

Aim: To estimate pregnancy outcomes associated with endometriosis in Ukraine.

Materials and Methods: We performed the multicentre prospective cohort study during the period from January 1st, 2019 to December 31st, 2021. The study included pregnant women aged \geq 18 years hospitalized in 17 hospitals from 15 regions of Ukraine. Logistic regression analysis provided odds ratios (OR) with 95% confidence intervals (CI).

Results: Of the 27,558 women, 990 (3,6%) reported a diagnosis of endometriosis before pregnancy. In 990 deliveries, women with endometriosis had a higher risk of hypertension in pregnancy (OR 1.2, 95% CI 1.0-1.3), preeclampsia (OR 1.4, 95% CI 1.3-1.5), severe preeclampsia (OR 1.7, 95% CI 1.5-2.3), hemorrhage in pregnancy (OR 2.3, 95% CI 2.0-2.5), placental abruption (OR 2.0, 95% CI 1.7-2.3), placenta previa (OR 3.9, 95% CI 3.5-4.3), premature rupture of membranes (OR 1.7, 95% CI 1.5-1.8), and retained placenta (OR 3.1, 95% CI 1.4-6.6). The neonates had increased risks of preterm birth before 28 weeks (OR 3.1, 95% CI 2.7-3.6), birth before 34 weeks (OR 3.2, 95% CI 2.8-3.6), being small for gestational age (OR 1.5, 95% CI 1.4-1.6), being diagnosed with congenital malformations (OR 1.3, 95% CI 1.3-1.4), and neonatal death (OR 1.8, 95% CI 1.4-2.1).

Conclusions: Pregnant women with endometriosis are at elevated risk for serious and important adverse maternal, fetal and neonatal outcomes. The magnitude of these complications calls for more intensive antenatal care of pregnant women with endometriosis.

KEY WORDS: endometriosis, adverse outcomes, pregnancy complications, obstetrical complications, neonatal complications, reproductive health, Ukraine

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INTRODUCTION

One of the important diseases in pregnant women is endometriosis. The most common localizations of pelvic endometriosis are the ovaries, the ligaments of the uterus, the Douglas pouch, and the fallopian tubes. Overall, the incidence of endometriosis is still unknown as there are no published cohort studies representative of the general population. According to the literature, approximately 10% of women of reproductive age have some degree of endometriosis. Characteristics robustly associated with a greater risk for endometriosis include early age at menarche, short menstrual cycle length, and lean body size, whereas greater parity has been associated with a lower risk [1]. Endometriosis has significant social, public health and economic implications.

Currently, endometriosis remains one of the most enigmatic disorders regarding its effects on pregnancy. Endometriosis adversely affects both natural and assisted conception. Furthermore, ruptured ovarian endometrioma, appendicitis, intestinal perforation, and hemoperitoneum have been described in pregnancy. Obstetricians are largely unfamiliar with these complications, as they have not been thoroughly investigated. Therefore, there is a rising need for a comprehensive study of the potential negative consequences of this condition on pregnancy outcomes, including the postpartum period, as more women with a medical history of endometriosis become pregnant. Obstetrical complications are statistically elevated in women with endometriosis. [2, 3].

In recent years, endometriosis has been linked to a spectrum of major pregnancy complications, which originate either in the ectopic implants or in the uterus. According to the literature, women with endometriosis had a significantly higher risk of several complications, such as preeclampsia and placental complications in pregnancy and at delivery. The newborns had increased risk of being delivered preterm, having congenital malformations, and having a higher neonatal death rate [4]. Therefore, the development and pathogenesis of endometriosis is an important field of study and has not yet been fully elucidated. Finding these mechanisms is crucial for the development of new and more effective strategies to treat this condition.

In Ukraine, endometriosis in pregnant women has known significant social, medical and economic impact. Despite the high prevalence of endometriosis among women of reproductive age, no additional monitoring is recommended for pregnancies with a history of endometriosis. There has been no study to explore the association between endometriosis and adverse pregnancy outcomes in women with and without endometriosis in Ukraine. Previous studies have focused on prevalence and risk factors for infertility in Ukraine [5].

AIM

The aim this study to estimate pregnancy outcomes associated with endometriosis in Ukraine.

MATERIALS AND METHODS

STUDY DESIGN, SETTING AND PATIENTS

We performed the multicentre prospective cohort study during the period from January 1st, 2019 to December 31st, 2021. The study included pregnant women aged \geq 18 years who were routinely examined and hospitalized in 17 maternal health hospitals from 15 regions of Ukraine. The inclusion criteria for this study were as follows: age \geq 18 years and singleton pregnancy. The exclusion criteria were unconsciousness or severe illness; learning difficulties or serious mental illness; major fetal abnormalities identified at the time of screening; endocrine, autoimmune, or systemic diseases, such as hypertension or diabetes; or other uterine disorders that could affect pregnancy development, such as uterine malformation.

DEFINITION

Pregnancy-induced hypertension (PIH) is defined as systolic blood pressure (SBP) above 140 mmHg and diastolic blood pressure above (DBP) above 90 mmHg. Hypertensive disorders of pregnancy were classified as gestational hypertension, chronic hypertension, chronic hypertension with preeclampsia, pre-eclampsia, or eclampsia. Preeclampsia was defined as persistently raised blood pressure ≥140/90 mmHg, occurring after >20 weeks of pregnancy in an otherwise normotensive woman, including gestational hypertension (preeclampsia without proteinuria), and gestational proteinuria (preeclampsia with proteinuria of \geq 300 mg protein in 24 h). The definition of gestational diabetes mellitus (GDM) is any degree of glucose intolerance with onset or first recognition during pregnancy. Gestational Cholestasis (GC) is a pregnancy-specific liver disease which manifests as maternal pruritus with deranged liver transaminases and/or elevated serum bile acids. Premature rupture of membranes (pPROM) is the rupture of membranes before 37 weeks of gestation. PROM is defined as the time from membrane rupture to onset of delivery was more than 18 hours. A diagnosis of PROM was confirmed with well-established clinical and/ or biological diagnostic procedures: the visualization of amniotic fluid passing from the cervical canal and pooling in the vagina; a basic pH test of the vaginal fluid; or arborization of the dried vaginal fluid, identified with microscopy. Miscarriage was defined as spontaneous abortion before 28 weeks of gestation. Antepartum hemorrhage (APH) is defined as bleeding from the canal birth of 15 mL or more, after 20 weeks of gestation, before the baby's birth. Postpartum hemorrhage (PPH) is defined as bleeding more than 500 mL within 24 h of vaginal delivery and greater than 750 mL after Caesarean section. Placental Abruption (PA) was defined as bleeding at the meconium-placenta interface results in partial or complete detachment of the placenta before delivery. Placental abruption (PA), also called abruptio placentae, occurs due to compromise of the vascular structures that support the placenta and represents the early separation of the placenta from the lining of the uterus before completion of the second stage of labor. The diagnosis of PA was based on clinical findings of abdominal pain, vaginal bleeding, uterine contractions, fetal distress, and abnormal vital signs. Placenta previa (PP) was defined as a placenta completely or partially covering the internal cervical os, based on transvaginal ultrasonography performed during the third trimester when the patient had an empty bladder. Spontaneous preterm birth (PTB) is defined as spontaneous labor before 37 completed weeks of gestation followed by live birth. Prematurity are liveborn infants delivered before

| | | Endometriosis | | | | | |
|---------------------------------|-----------------------------|---------------|------------------|--------|-----------------|-------|--|
| Characteristics | All patients N=27,558 | | Yes N=990 | N | No N=26,568 | | |
| | | n | % | n | % | | |
| Maternal age, years | | | | | | | |
| < 20 | 769 | 3 | 0.3 | 766 | 2.9 | <0.01 | |
| 20–24 | 2,083 | 27 | 2.7 | 2,056 | 7.7 | | |
| 25–29 | 5,970 | 156 | 15.8 | 5,814 | 21.9 | | |
| 30–34 | 8,508 | 330 | 33.3 | 8,178 | 30.8 | | |
| 35–39 | 5,269 | 285 | 28.8 | 4,984 | 18.8 | | |
| 40-44 | 3,142 | 144 | 14.6 | 2,998 | 11.3 | | |
| ≥ 45 | 1,817 | 45 | 4.5 | 1,772 | 6.6 | | |
| Smoking status | | | | | | | |
| Never | 3,066 | 131 | 13.2 | 2,935 | 11.0 | 0.78 | |
| Former | 6,168 | 236 | 23.8 | 5,932 | 22.3 | | |
| Current | 18,324 | 623 | 62.9 | 17,701 | 66.6 | | |
| Alcohol drinking | | | | | | | |
| Non- | 9,092 | 300 | 30.3 | 8,792 | 33.1 | 0.53 | |
| Ex- | 16,565 | 624 | 63.0 | 15,941 | 60.0 | | |
| Current | 1,069 | 35 | 3.6 | 1,034 | 3.9 | | |
| Missing | 832 | 31 | 3.1 | 801 | 3,0 | | |
| Gestational age | | | | | | | |
| weeks, median [range] | | | 39.0 [15.0–42.1] | | 39.3 [7.4–42.3] | | |
| < 22 | 255 | 15 | 1.5 | 240 | 0.9 | <0.01 | |
| 22–37 | 1,619 | 102 | 10.3 | 1,517 | 5.7 | | |
| 37–42 | 25,541 | 867 | 87.6 | 24,674 | 92.9 | | |
| ≥ 42 | 59 | 3 | 0.3 | 56 | 0.2 | | |
| Missing | 84 | 3 | 0.3 | 81 | 0.3 | | |
| Parity | | | | | | | |
| 0 | 10,002 | 423 | 42.7 | 9,579 | 36.1 | <0.01 | |
| 1 | 10,446 | 345 | 34.8 | 10,101 | 38.0 | | |
| 2 | 4,434 | 123 | 12.4 | 4,311 | 16.2 | | |
| > 3 | 1,268 | 36 | 3.6 | 1,232 | 4.6 | | |
| Missing | 1,408 | 63 | 6.4 | 1,345 | 5.1 | | |
| Mode of delivery | | | | | | | |
| Vaginal delivery | 22,339 | 732 | 73.9 | 21,607 | 81.3 | <0.01 | |
| Cesarean section | 5,219 | 258 | 26.1 | 4,961 | 18.7 | | |
| History of infertility | 14,199 | 171 | 17.3 | 14,028 | 52.8 | <0.01 | |
| History of oral contractive use | 24,716 | 838 | 84.6 | 23,878 | 89.9 | 0.49 | |
| Age at menarche (years) | | | | | | | |
| 11 or younger | 7,656 | 230 | 23.2 | 7,426 | 28.0 | 0.78 | |
| 12–13 | 15,798 | 580 | 58.6 | 15,218 | 57.3 | | |
| 14 or older | 4,094 | 180 | 18.2 | 3,914 | 14.7 | | |

Table 1. Baseline maternal characteristics according to endometriosis status for women delivering singleton births during 2019–2021 in Ukraine

37 weeks of pregnancy (based on the Ballard score or from first day of the last menstrual period). Low birth weight (LBW) neonate is neonate whose birth weight is less than 2,500 grams. Small for gestational age (SGA) is defined as the weight of the baby at birth that is less than 10th percentile for GA.

| Table 2. Pregnancy and neonat | al outcomes in women | with and without er | ndometriosis in Ukraine | 2019-2021 |
|-------------------------------|----------------------|---------------------|-------------------------|-----------|
|-------------------------------|----------------------|---------------------|-------------------------|-----------|

| Outcome | Total | Ye | 25 | No |) | Adjusted OR |
|--------------------------------|--------|-----|-----|--------|-----|---------------|
| | | n | % | n | % | |
| All women | | | | | | |
| Number of births | 27,558 | 990 | | 26,568 | | |
| Complications in pregnancy | | | | | | |
| Hypertension in pregnancy | 492 | 22 | 2.2 | 470 | 1.8 | 1.2 (1.0–1.3) |
| Preeclampsia | 603 | 31 | 3.1 | 572 | 2.2 | 1.4 (1.3–1.5) |
| Severe preeclampsia | 239 | 13 | 1.3 | 226 | 0.9 | 1.7 (1.5–2.3) |
| Placental abruption | 183 | 11 | 1.1 | 172 | 0.6 | 2.0 (1.7–2.3) |
| Premature rupture of membranes | 386 | 24 | 2.4 | 362 | 1.4 | 1.7 (1.5–1.8) |
| Placenta previa | 168 | 23 | 2.3 | 145 | 0.5 | 3.9 (3.5–4.3) |
| Antepartum hemorrhage | 200 | 16 | 1.6 | 184 | 0.7 | 2.3 (2.0–2.5) |
| Neonatal complications | | | | | | |
| Birth before 28 weeks | 102 | 10 | 1.0 | 92 | 0.3 | 3.1 (2.7–3.6) |
| Birth before 34 weeks | 1,657 | 51 | 5.1 | 1,606 | 6.0 | 3.2 (2.8–3.6) |
| SGA | 1,353 | 73 | 7.3 | 1,280 | 4,8 | 1.5 (1.4–1.6) |
| Apgar score (<7 after 5 min) | 223 | 12 | 1.2 | 211 | 0.8 | 1.4 (1.2–1.6) |
| Congenital malformations | 1,514 | 71 | 7.1 | 1,443 | 5.4 | 1.3 (1.3–1.4) |
| Stillborn | 151 | 6 | 0.6 | 145 | 0.5 | 1.2 (1.0–1.5) |

*OR, odds ratio; CI, confidence interval.

DATA COLLECTION

In this study, each woman completed a questionnaire regarding her past history of endometriosis, reporting whether she had been diagnosed with endometriosis during the past year, ever had endometriosis, and ever received infertility treatment. This study did not take into account the period between diagnosis of endometriosis and the occurrence of pregnancy. On the baseline guestionnaire, participants reported a number of characteristics, including smoking history; alcohol drinking; age at menarche; menstrual cycle length; oral contraceptive use; parity (number of pregnancies lasting 6 months or longer); history of infertility (more than 12 months trying to conceive without success) and menopausal status. Trained research coordinators collected data concerning obstetrical complications and neonatal outcomes from medical records in the obstetrics institutions. Our main outcomes of interest for this analysis were pregnancy outcomes and maternal complications, including PIH, hypertensive disorders of pregnancy (preeclampsia or gestational hypertension), GDM, GC, PROM, APH, PPH, PA, PP, PTB, LBW, SGA, and APGAR scores at 1 min and 5 min.

ETHICS

The Ethics Committee of Shupyk National Healthcare University of Ukraine approved the study. All methods were performed according to the Declaration of Helsinki. All study participants signed a general consent form for using their clinical data for scientific purposes.

STATISTICAL ANALYSIS

All data were analyzed using Stata version 15.1 (StataCorp., College Station, TX, USA). Dichotomous data are presented as percentages and were compared between the two groups with the χ 2 test or a nonparametric test (Fisher's exact test). Continuous data are presented as the mean±standard deviation (SD) and were analyzed with an independent-samples t-test or a nonparametric test. In the outcome analysis, relative risks and differences in absolute risk were calculated for dichotomous outcomes, together with their 95% confidence intervals (95% CI), using Fisher's exact test. All outcomes were analyzed by multivariate logistic regression to calculate odds ratios (OR) with 95% confidence intervals (CI). Significance was set at p<0.05.

RESULTS

A total of 27,558 pregnant women were enrolled whose pregnancy terminated between January 1st, 2019 to December 31st, 2021. Of the 27,558 participants, 990 (3,6%) reported a diagnosis of endometriosis before pregnancy. All women con-

| 1 | , | | | | | |
|---|--------|---------------|------|--------|------|---------------|
| | | Endometriosis | | | | |
| Outcome | Total | Y | ′es | No |) | Adjusted OR |
| | | n | % | n | % | |
| All women | | | | | | |
| Number of births | 27,558 | 990 | | 26,568 | | |
| Complications in labor | | | | | | |
| Perineal laceration grade 3 and 4 | 877 | 36 | 3.6 | 841 | 3.2 | 1.0 (0.9–1.1) |
| Rupture of the uterus (before and during labor) | 41 | 3 | 0.3 | 38 | 0.1 | 2.7 (2.0–3.6) |
| Postpartum hemorrhage (all deliveries first week) | 2,770 | 96 | 9.7 | 2,674 | 10.1 | 0.9 (0.9–1.0) |
| Postpartum hemorrhage after cesarean | 2,913 | 28 | 2.8 | 2,885 | 10.9 | 1.1 (1.0–1.2) |
| Postpartum hemorrhage after vaginal delivery | 2,699 | 68 | 6.9 | 2,631 | 9.9 | 1.0 (0.9–1.0) |
| Retained placenta (placenta accreta/percreta) | 0 | 0 | 0.0 | 0 | 0.0 | 3.1 (1.4–6.6) |
| Procedures in labor | | | | | | |
| Vacuum extraction | 2,420 | 79 | 8.0 | 2,341 | 8.8 | 1.2 (1.1–1.3) |
| Evacuation of the uterus | 67 | 2 | 0.2 | 65 | 0.2 | 1.5 (1.1–2.2) |
| Intrauterine palpation | 277 | 9 | 0.9 | 268 | 1.0 | 1.2 (1.0–1.4) |
| Manual removal of the placenta (vaginal delivery) | 439 | 17 | 1.7 | 422 | 1.6 | 1.3 (1.2–1.5) |
| Cesarean section – emergency before labor | 613 | 45 | 4.5 | 568 | 2.1 | 2.1 (2.0–2.3) |
| Cesarean section – planned | 1,960 | 116 | 11.7 | 1,844 | 6.9 | 1.7 (1.7–1.8) |
| Cesarean section – emergency in labor | 1.731 | 89 | 9.0 | 1.642 | 6.2 | 1.8 (1.7–1.9) |

| Table 3. Birth com | plications in wom | en with and withou | ıt endometriosis in | Ukraine | , 2019-2021 |
|--------------------|-------------------|--------------------|---------------------|---------|-------------|
|--------------------|-------------------|--------------------|---------------------|---------|-------------|

*OR, odds ratio; CI, confidence interval.

ceived naturally. The study participants' characteristics, age, smoking, and alcohol drinking were similar between women with and without endometriosis. Baseline maternal characteristics (socio-demographic and gynecological) according to endometriosis status for women delivering singleton births during 2019–2021 in Ukraine are presented in Table 1.

A total 7,271 (26.4%) of the 27, 558 participants were diagnosed with complications in pregnancy. The most all pregnancy complications occurred more frequently in women with endometriosis than in women without endometriosis. As shown in Table II, the OR of preeclampsia was 1.4 (95% Cl 1.3–1.5) and for severe preeclampsia, eclampsia 1.7 (95% Cl 1.5–2.0). In this study the OR of placenta previa was 3.9 (95% Cl 3.5–4.3) and of placental abruption 2.0 (95% Cl 1.7–2.3). Premature rupture of membranes and hemorrhage after 22 gestational weeks in women were both significantly increased in women with endometriosis. Pregnancy and neonatal outcomes in women with and without endometriosis in Ukraine are presented in Table 2.

In this study women with endometriosis had an OR of uterine rupture of 2.7 (95% Cl 2.0–3.6), and of retained placenta (placenta accreta/percreta) of 3.1 (95% Cl 1.4–6.6). For retained placenta with manual removal the OR was 1.3 (95% Cl 1.2–1.5) and for evacuation of the uterus after delivery 1.5 (95% Cl 1.1–2.2). Interestingly the OR for postpartum hemorrhage was slightly

lower in women with endometriosis than in unexposed women. When stratified by mode of delivery, women with endometriosis who delivered by cesarean section had an OR of bleeding of 1.1 (95% CI 1.0–1.2). In this study women with endometriosis had more neonatal complications: stillbirth, neonatal death, preterm birth before 28 weeks, and preterm birth before 34 weeks. Among neonates of women with endometriosis, the OR of small-for-gestational age was 1.5 (95% CI 1.4–1.6), of low Apgar score 1.4 (95% CI 1.2–1.6) and of malformations diagnosed within the first year 1.3 (95% CI 1.3–1.4). Birth complications in women with and without endometriosis in Ukraine are presented in Table 3.

The incidence of adverse pregnancy outcomes associated with endometriosis varied widely within Ukraine, from 7% in three regions (Poltava, Sumy, and Cherkasy) to \geq 38% in eight, mostly in southern (Odesa, Dnipro, Zaporizhzhia, Kropyvnytskyi, Kherson), eastern (Kharkiv), and central (Kyiv, Zhytomyr) Ukraine. The incidence of adverse pregnancy outcomes associated with endometriosis in Lviv, Rivne, and Chernivtsi varied from 18% to 33%.

DISCUSSION

The present study is the first in Ukraine to show a significant impact of endometriosis on the incidence

of adverse pregnancy outcomes. Our study is so far the largest and most detailed study of obstetrical and neonatal complications in women with endometriosis in Ukraine. In this study, we addressed the association between endometriosis and adverse pregnancy outcome, including gestational hypertension, pre-eclampsia, low birth weight, and small for gestational age, preterm birth, placenta previa, placental abruption, cesarean section, stillbirth, postpartum hemorrhage, and spontaneous hemoperitoneum in pregnancy in female in Ukraine. This study showed that endometriosis significantly increased the incidence of adverse pregnancy outcomes. Women with endometriosis had a higher risk of several adverse outcomes in pregnancy and at delivery. Also, the neonates had an increased risk of being delivered preterm, having congenital malformations, and neonatal death. Overall, our findings indicate an association between endometriosis and gestational hypertension, preeclampsia, preterm birth, placenta previa, placental abruption, cesarean section, and stillbirth. In general, our findings confirm the results of other sizable studies, whereas smaller studies have shown varying results, likely due to small sample size, and other methods or study design.

In literature, the incidence rate and prevalence of endometriosis has been debated. It is estimated that approximately 10% of women of reproductive age have some degree of endometriosis [1] In our study, the past history of endometriosis was determined by questionnaire, and a pregnant woman reported whether she had been diagnosed with endometriosis during her lifetime. Therefore, the diagnostic accuracy of endometriosis was reflected in a self-reported guestionnaire. Endometriosis can be associated with a wide variety of symptoms, or it may be asymptomatic and incidentally observed at laparoscopy or exploratory surgery. Laparoscopic surgery and histological examination are strictly required for a precise diagnosis of endometriosis. In contrast, Ukrainian gynecologists routinely examine the patient's uterus and ovaries in the first examination using transvaginal ultrasonography.

According to the literature, adverse impact of pelvic endometriosis on uterine function before conception may also interfere with subsequent deep placentation, including preterm birth and antepartum hemorrhage. Brosens et al. considered the pathological pathway, including the altered junctional zone myometrium that causes the clinical consequences of uterine dysfunction associated with pelvic endometriosis [6]. Thus, both the coexistence of endometriosis and pregnancy and endometriosis before pregnancy may affect obstetrical complications.

In a Danish study in 19 331 deliveries, women with endometriosis had a higher risk of severe preeclamp-

sia, hemorrhage in pregnancy, placental abruption, placenta previa, premature rupture of membranes, and retained placenta. The neonates had increased risks of preterm birth before 28 weeks, being small for gestational age, being diagnosed with congenital malformations, and neonatal death [4]. In an Australian study of 6730 singleton births of women, endometriosis was found to be a risk factor of placenta previa [7], a finding supported in a recent study of late pregnancy complications in 4232 women with endometriosis [8]. A large Swedish study showed an increased risk of antepartum hemorrhage/placental complications in women with endometriosis, but it was not possible to distinguish between the clinically different entities of antepartum bleeding, placental abruption and placenta previa [9]. In our study women with endometriosis had a higher risk of extremely preterm birth regardless of parity and plurality, which is in accordance with most other studies [8-11]. Another factor is the higher rate of iatrogenic preterm delivery because of the higher incidence of placenta previa, premature rupture of membranes and preeclampsia. Preterm delivery likely explains the higher risk of neonatal death, as sub-analysis on neonates born at term removed this increased risk.

According to the literature, in women pregnancies the implantation of the blastocyst into a receptive endometrium, successful placentation, and remodeling of the uterine vasculature require the integration of a number of critical stages. Dysfunction may occur in several stages of the process, and pregnancy complications are thought to depend on the dysregulation of such events [12]. In women affected by endometriosis, several adverse events may occur in the peri-implantation period as well as throughout the pregnancy, including endometrial resistance to selective actions of progesterone, inflammatory processes at the endometrial and systemic levels, inadequate uterine contractility, and endometrial excessive activation of free radical metabolism [13-17]. All these alterations of the local endometrial environment have been described in women with endometriosis as well as in women at risk of preterm labor, fetal growth restriction, and placental disorders [18].

The association between endometriosis and adverse pregnancy outcomes has drawn more attention in recent years with fairly consistent evidence of increased risks for caesarean section, preterm birth, and stillbirth [19, 20]. However, the link with gestational diabetes, preeclampsia, or intrauterine growth restriction remains less clear due to heterogeneity in study designs and methodologies used in previous studies [9, 21-25]. In epidemiology, it remains challenging to study the direct impact of endometriosis on pregnancy outcomes, and underlying mechanisms are not well understood.

STRENGTH AND LIMITATIONS

This is the first Ukrainian multicenter cohort study to estimate the association between endometriosis and adverse pregnancy outcomes. This work may be considered the first of more-detailed epidemiological studies of endometriosis in Ukraine in order to estimate the association between endometriosis and adverse pregnancy outcomes in Ukraine. In this study, the data of obstetrical complications and neonatal outcomes were collected prospectively by trained research coordinators for all puerperal patients from the medical records. Therefore, we expect the self-reported questionnaire and the outcome of delivery to be accurate.

Our study has some limitations. One of the weak points of this study is that the diagnostic accuracy of endometriosis is just referred by the self-reported guestionnaire. Another limitation was that we did not have information on histological confirmation of the diagnosis of endometriosis. Little information is available concerning with the medical records of the participants for endometriosis. It is unclear how many out of 990 women had active endometriosis during their pregnancies. This study did not take into account whether the affected women were treated for endometriosis before pregnancy and what kind of treatment was given. Furthermore, it is unclear whether obstetrical complications are affected by pre-pregnancy treatment or the coexistence of endometriosis during pregnancy. In this study, we did not conduct a stratified analysis of the types of endometriotic lesions or the presence or absence of adenomyosis. Moreover, the variability in the existing diagnostic criteria for endometriosis, the heterogeneity and the potential confounding factors that were not accounted for (such as the type of endometriotic lesions, the presence or absence of adenomyosis, the use of assisted reproductive techniques, etc.) weaken the validity of our research results. Similarly designed

studies have reported different results, so the pathogenesis of endometriosis requires further research to confirm our findings.

CONCLUSIONS

Endometriosis is a common benign gynecological disorder; however, delivery outcomes concerning pregnancies with endometriosis remain understudied. Our study showed that women with endometriosis are at elevated risk for serious and important adverse maternal, fetal and neonatal outcomes. Endometriosis increases the risk of pregnancy complications and neonatal morbidity. Women with endometriosis had a higher risk of hypertension in pregnancy, pre-eclampsia, severe preeclampsia, hemorrhage in pregnancy, placental abruption, placenta previa, premature rupture of membranes, and retained placenta. The neonates had increased risks of preterm birth before 28 weeks, birth before 34 weeks, being small for gestational age, being diagnosed with congenital malformations, and neonatal death. A more comprehensive understanding of this disease may allow timely prevention and treatment of the related complications and ultimately improve maternal and neonatal outcomes. The magnitude of these complications calls for more intensive antenatal care of pregnant women with endometriosis. Clinicians should consider the possibility of endometriosis in pregnant women. Since a diagnosis of endometriosis during pregnancy is challenging, a medical consultation would be helpful to determine whether endometriosis is present or whether there has been any past surgical history of endometriosis prior to pregnancy. This information might be helpful for women and their providers when managing these pregnancies. Further studies are required to assess whether any modification is needed to conventional pregnancy monitoring for patients with endometriosis.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Aidyn G. Salmanov

Shupyk National Healthcare University of Ukraine 9 Dorohozhytska St., 04112 Kyiv, Ukraine e-mail: mozsago@gmail.com

ORCID AND CONTRIBUTIONSHIP

Aidyn G. Salmanov: 0000-0002-4673-1154 A C D E F Volodymyr V. Artyomenko: 0000-0003-2490-375X B C D F Andrii O. Shchedrov: 0000-0002-1737-9171 B C D F Andrii P. Prishchepa: 0009-0008-0246-581X B C D F Svitlana M. Korniyenko: 0000-0003-3743-426X B C D F Andriy I. Chubatyy: 0000-0003-0375-5556 B C D F Igor V. Maidannyk: 0000-0003-0849-0406 B C D F Olena O. Chorna: 0000-0002-9137-5056 B C D F Victor O. Rud: 0000-0002-0768-6477 B C D F Vitalii S. Strakhovetskyi: 0000-0002-7528-1498 B C D F Mykhailo V. Knyhin: 0009-0009-8622-338X B C D F Anastasia S. Padchenko: 0009-0007-6382-8955 B C D F

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ORIGINAL ARTICLE

CONTENTS 💋

Increasing the efficiency of dental disease prevention in children of younger school age through participation in a stomatological performance

Olga V. Sheshukova, Tetiana V. Polishchuk, Valentyna P. Trufanova, Sofia S. Bauman, Kateryna S. Kazakova, Anna S. Mosiienko, Alina I.Maksymenko POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE

ABSTRACT

Aim: To study the awareness of children and their parents in the prevention of dental diseases and to propose educational measures to increase it. **Materials and Methods:** To achieve the goal of the study, a survey of 628 children, aged 7-11 years, younger schoolchildren of Poltava and 479 of their parents was conducted using the previously developed "Dental Questionnaire for Children and Parents". The questionnaire was based on the main indicators of the dental health of children and adolescents in accordance with the EGOHID II project (2008) and the WHO dental questionnaire (2013), and it took into account the proposals of dental organizations that regulate the assessment of oral health in children. Based on the results of the survey, a script for oral hygiene lesson for junior schoolchildren was developed using theatrical and game elements.

Results: The results of the conducted research indicate the low sanitary and hygienic awareness of parents, the paternalism of their thinking, which leads to the lack of control over the hygiene of the oral cavity of children. In order to solve this problem, a scenario of informational explanatory conversation was created with the involvement of modern methods of communication and intern doctors who have acquired relevant knowledge and communication skills. **Conclusions:** Informing of children about the prevention of dental diseases in the form of a dental performance is a relevant sanitary and educational event that motivates children to observe the rules of oral hygiene.

KEY WORDS: children, caries, prevention of dental diseases, oral hygiene

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INTRODUCTION

Modern demands of society for education activate the need for improvement of learning technologies in higher educational institutions, including medical ones. The influence of integration processes strengthens the connection of different branches of science and practice, which positively affects the quality of training of specialists. The training of a pediatric dentist at the post-graduate stage involves the integration of dentistry, pediatrics and pedagogical science. After all, the competitiveness of specialists in the modern labor market, which is quite tough and demanding, largely depends on the level of their professional training, experience of practical work, and level of communication. It is common knowledge that the formation of a system of knowledge, abilities and skills is carried out gradually: step by step, from easy to complex.

Providing high-quality dental care to children is an extremely relevant issue today, which depends equally on the clinical knowledge and practical skills of the dentist, as well as on the ability to exert a positive

psychological influence on the child. A very important component during a dental appointment is the presence of psychological interaction with the child, therefore, at the post-graduate stage of training in the "Pediatric Dentistry" cycle, when teaching the material, these aspects are given considerable attention.

The main task in the professional activity of a children's dentist is the ability to convey knowledge about oral hygiene among broad segments of the population. That is why intern doctors of the department improve their skills in conducting sanitary and educational work, as one of the links of primary prevention of dental diseases in children.

Interns take part in the preparation and implementation of dental sanitary and educational projects in preschool and school educational institutions. Protection of children's rights to health care and health promotion is an integral field of activity that closely connects the interests of doctors, including children's dentists, teachers, psychologists, parents and the entire community as a whole. Over the last decade, there has been an increase in the number of children with health abnormalities – these are children who are often and for a long time sick and those who have chronic somatic pathology. As they grow older, the number of practically healthy children decreases significantly, but the number of children with diseases of the oral cavity increases. However, the problem of dental health of children can't be solved only by the efforts of children's dentists without integration with teachers [1]. Therefore, it is advisable to use educational technologies that allows preserving children's health and forming a positive attitude towards a healthy lifestyle [2].

The dental health of children of primary school age is the main component in the formation of the dental health of the child as a whole, therefore a comprehensive approach from dentists, pediatricians, teachers, psychologists and parents is necessary to preserve and strengthen health. The implementation of technologies [3] aimed at preserving health, in practice, takes place consistently in close contact with all specialists.

One of the main principles for the formation of hygienic skills and habits in children is the achievement of a positive attitude to treatment. In order for a child, and in the future, an adult to visit the dentist regularly for the purpose of preventive and curative care, it is necessary to have a stable, formed positive relationship.

AIM

The aim of the work is to study the awareness of children and their parents in the prevention of dental diseases and to propose educational measures to increase it.

MATERIALS AND METHODS

A survey of 628 children, aged 7-11 years, younger schoolchildren of Poltava and 479 of their parents was conducted using the previously developed "Dental Questionnaire for Children and Parents" [4]. The questionnaire was based on the main indicators of the dental health of children and adolescents in accordance with the EGO-HID II project (2008) and the WHO dental questionnaire (2013), and it took into account the proposals of dental organizations that regulate the assessment of oral health in children [5,6]. Based on the results of the survey, a script for oral hygiene lesson for junior schoolchildren was developed using theatrical and game elements.

RESULTS

Based on the results of the survey, we found out that only about 70% of the interviewed children brush their teeth every day, and less than half of them do it twice a day (33.5%). 85.03% of the interviewed children noted that they brush their teeth independently without the help of adults. In turn, 89.14% of parents answered positively to the question of whether the child brushes his teeth independently, and only 27.6% of parents controlled the brushing process. Most parents do not understand the need to control and help a child of primary school age in the process of hygienic care of the oral cavity.

Only a third of children with parents (29.02%) visited the dentist for a routine check-up, in 36.5% of cases it was pain and problems with teeth and gums, and 34.45% of parents accompanied the child to repeat treatment.

According to the results of our survey, the majority of parents (63.5%) are afraid to visit a dentist. It is most likely that they pass their fear on to their children, as 47.5% of parents note that their children are afraid of the dentist.

Parents consider the Internet to be the main source of knowledge about oral hygiene (72% of respondents), and it is a great pity that only 15.9% of parents consider educational programs in schools informative.

The data obtained as a result of this and our previous study indicate of low sanitary and hygienic awareness of parents, paternalism of their thinking, which leads to the lack of control over oral hygiene of children [7]. A successful solution to this problem is possible only by carrying out information and explanatory activities with the involvement of modern methods of communication and the participation of people who have already undergone appropriate training. Sanitary and educational work should be organized mostly informally with the involvement of modern methods of communication and information technologies in the form of live communication between those who teach and those who study, with the opportunity for the latter to ask questions and receive answers. The material to be mastered should be modern, structured, understandable and presented taking into account the age of the audience.

Based on the results of the questionnaire, we made a decision to strengthen sanitary and educational work aimed at reducing children's wariness of visiting the dentist and improving their knowledge about oral hygiene and healthy eating habits, as well as bringing knowledge about dental hygiene to parents and encouraging them to more responsibility for the health of their children's teeth.

For a long time, the lecturers of the department, together with intern doctors, worked on the implementation of measures for the primary prevention of dental caries among children of primary school age. The forms and methods of primary prevention that we implemented are diverse, and included both individual and group measures to teach children about hygienic dental care. The main task of the doctor, which is also a test of his professional skills, is to find an opportunity to cooperate with each child in order to achieve mutual understanding.

In order to bring the doctor closer to the child, relieve the tension before dental treatment, and convey to them the knowledge of hygiene in a playful way, we created a "dental" performance, for which the lecturers and interns wrote the screenplay, selected music, and video materials about the tools hygiene and staging. The participants-actors in it are both intern doctors and the youngest schoolchildren who are involved during the action. The main positive characters of the play are dental saviors, whose role is performed by intern doctors. With the help of pre-created small videos, they demonstrate positive practices to the audience - food products, hygiene products, and rules for their use that are useful for healthy teeth. The practical part of the lesson with the children was conducted in the form of a hygiene lesson with a demonstration of the structure of the tooth, "carious monsters" that destroy teeth, hygiene products and practice on jaw models of the most optimal methods of brushing teeth. Schoolchildren are involved in the action by answering quiz questions about food products that are useful and dangerous for teeth, and repeating the correct manipulations when brushing teeth with a toothbrush on a model of jaws. It is important to interest children and involve each of them in participating in the practical component of the event, as well as to arouse interest and desire to repeat hygienic manipulations on their own.

Theatrical hygiene lesson is interesting, first of all, because it brings a holiday atmosphere, joyful feelings into the lives of younger schoolchildren, and allows children to show their initiative and communication skills. The main means of development of the motivational sphere in children of primary school age is play, therefore, such a psychological feature of children as inquisitiveness was used for hygienic education.

Control over the assimilation of the demonstrated material rests on educators and parents, because one of the important mechanisms of the influence of others on the child is a living example and stimulation for imitation [8, 9]. Therefore, the staff of the department prepared reminders and booklets for schoolchildren, educators and parents, from which each of them can get comprehensive information on dental health issues in children. So, we have offered parents the reminders «What parents need to know about children's teeth» and «The need for regular visits to the dentist by a child», in which the main important knowledge for parents about the development of the children's dental and jaw system, the need for regular dental care are presented in a concise form and hygiene algorithms. The note «A child's first visit to the dentist» emphasizes the attention of parents on the stages of psychological preparation of a child to visit a dentist, describes the scenario of the most optimal first dental appointment. The attractions are illustrated with attractive photos, diagrams, and contain interesting information. The atrical play "Dental Hygiene Lesson" aroused the interest of children, their parents and educators and became an excellent incentive for motivation to hygienic dental care, contributed to the formation of a positive image of the dentist as a friend and assistant.

DISCUSSION

According to many researchers, sanitary and educational work in organized children's groups should be a priority for children's dentists. Active educational events for children with the involvement of intern doctors, who through communication with schoo lchildren deepen not only their professional knowledge, but also gain experience of speaking in front of an audience, learn to reasonedly answer questions, and motivate them to have the right attitude to dental health are particularly relevant [10].

In our opinion, sanitary and educational work in the form of hygiene lessons helps in the formation of a healthy lifestyle, provides children with a cognitive opportunity to consciously exclude risk factors and maintain a level of health, which subsequently leads to a decrease in the increase in the intensity of dental caries in children of this age group.

When conducting dental training, it is necessary to achieve regular and systematic activities for the formation of permanent oral hygiene skills and awareness of the importance of caring for one's dental health in a child [11].

Active familiarization of parents of children of primary school age with the rules of care for the oral cavity of children and about the methods of prevention of dental diseases play great role in reducing of the prevalence of early childhood caries [12]. For the successful involvement of parents in the care of children's oral cavity, printed informational materials play a significant role – reminders that provide information on the main aspects of dental hygiene in a concise form.

The creative approach to conducting of the hygiene lessons in schools in the form of a kind of dental performance aroused great interest among intern doctors in expanding their knowledge on the prevention of dental diseases, stimulated and supported the need for serious creative efforts with a creative search for non-traditional, alternative methods of forming a positive attitude to prevention in children.

Innovative projects and methods activate the mental activity of medical interns, develop their creativity, improve skills to find non-standard ways of solving dental problems, develop communication and psychological abilities, promote mutual communication and cooperation in the team. In this manner, future dentists have the opportunity to learn in practice how to implement the dental component of health-preserving technologies in close cooperation with educators, pediatricians and parents.

CONCLUSIONS

The method of conveying knowledge about the prevention of dental diseases to younger schoolchildren in the form of a dental performance is a relevant sanitary and educational event that motivates children to observe the rules of oral hygiene.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Valentyna P. Trufanova

Poltava State Medical University 23 Shevchenka str. 36011 Poltava, Ukraine e-mail: trufanovav4@gmail.com

ORCID AND CONTRIBUTIONSHIP

Olga V. Sheshukova: 0000-0002-4739-4890 A,E,F A B C D E F Tetiana V. Polishchuk: 0000-0003-1114-5830 B C Valentyna P. Trufanova: 0000-0002-7819-0188 B C D Sofia S. Bauman: 0000-0002-9029-8968 B C Kateryna S. Kazakova: 0000-0003-2645-5778 B C Anna S. Mosiienko: 0000-0003-2129-8304 B C Alina I.Maksymenko: 0000-0002-9791-0873 B C

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Improving the management of morbidly obese patients with postoperative bleeding undergoing Roux-en-Y gastric bypass

Oleksander Y. loffe, Victor O. Nevmerzhytskyi, Mykola S. Kryvopustov, Yurii P. Tsiura, Taras M.Galyga, Stepan L. Kindzer, Vladislav M. Perepadya

BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE

ABSTRACT

Aim: To improve the management of morbidly obese patients who undergo gastric bypass surgery to reduce the number of postoperative complications, in particular, bleeding.

Materials and Methods: From 2011 to 2022, a total of 348 patients with morbid obesity (MO) underwent laparoscopic gastric bypass treatment at the clinical base of the Department of General Surgery №2 of Bogomolets National Medical University. The retrospective group included 178 patients who received treatment between 2011 and 2019. 170 patients were enrolled in the prospective group for the period from 2019 to 2022.

Results: Retrospective group had 8 episodes of postoperative bleeding, representing a rate of 4.49%, prospective group – 3 episodes of postoperative bleeding, representing a rate of 1.76% Four factor characteristics associated with the probability of bleeding were identified: "number of comorbid conditions", "arterial hypertension", "chronic liver diseases" and "chronic obstructive pulmonary disease"

Conclusions: The factors responsible for the occurrence of postoperative bleeding in morbidly obese patients after laparoscopic gastric bypass surgery were the number of comorbid conditions, the presence of arterial hypertension, the presence of chronic liver diseases, and chronic obstructive pulmonary disease. A new strategy for the management of morbidly obese patients after laparoscopic gastric bypass was developed. This strategy involves changing cassettes to create gastroentero- and enteroenteroanastomoses, reducing the period of use of the nasogastric tube, drains, and urinary catheter from 3-4 days to 1 day, and resuming the drinking regimen 6 hours after extubation.

KEY WORDS: metabolic surgery, gastric bypass, complication, bleeding, treatment, prevention, ERAS protocol

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INTRODUCTION

The prevalence of obesity has become a major concern in the healthcare system, as it is associated with an increase in morbidity rates and is indicative of a global epidemic. In May 2022, the World Health Organisation released data showing that 59% of the European population suffers from obesity, with excess body weight observed in 8% of children under the age of 5 and in one out of every 3 school-age children [1].

Obesity is a significant risk factor for nonalcoholic fatty liver disease, cardiovascular disease, diabetes, 12 types of malignancy, and psychiatric disorders [2].

Laparoscopic gastric bypass is a highly efficient method for managing morbid obesity. According to the IFSO (8th Global Registry Report, 2023), a total of 480,970 bariatric operations were performed in 2022. Out of these, laparoscopic gastric bypass was the initial procedure in 28.8% of patients [3].

Global research indicates that postoperative complications following laparoscopic gastric bypass arise in 5.86.4% of patients. Postoperative bleeding is categorised as either early (within 30 days) or late (beyond 30 days). It is further classified based on its location within the gastrointestinal tract, either within the lumen (intraluminal) or within the abdominal cavity (intraperitoneal). Within a 24-hour period after surgery, bleeding occurs in 43% of patients [4].

Recent studies have identified several common risk factors for postoperative bleeding. They include the therapeutic use of anticoagulants, renal insufficiency, co-agulopathy, chronic liver disease, hypertension, chronic lung disease, and being over the age of 45 [5].

AIM

The aim of the study was to improve the management of morbidly obese patients who undergo gastric bypass surgery to reduce the number of postoperative complications, in particular, bleeding.

MATERIALS AND METHODS

From 2011 to 2022, a total of 348 patients with morbid obesity (MO) underwent laparoscopic gastric bypass treatment at the clinical base of the Department of General Surgery No. 2 of Bogomolets National Medical University.

A retrospective analysis was conducted on patients with morbid obesity who underwent laparoscopic gastric bypass surgery to assess patient management and reduce postoperative bleeding. The retrospective group included 178 patients who received treatment between 2011 and 2019. Of these patients, 86 (48.3%) were male and 92 (51.7%) were female. The mean body weight was 144.8 (95% CI: 142.7–146.8) kg, and the mean body mass index (BMI) was 45.44 (95% CI: 44.67–46.22) kg/m2. The surgical and anaesthetic risk, as assessed by the ASA scale, was 3.36 (95% CI: 3.25-3.47). There were 8 episodes of postoperative bleeding, representing a rate of 4.49% (Table 1).

Preoperative assessment included: complete blood count, complete urinalysis, biochemical blood count (total protein, ALT, AST, total bilirubin with fractions, urea, creatinine), coagulogram, blood group and rhesus, electrocardiography, echocardiography, a chest X-ray, an abdominal ultrasound, cardiologist and pulmonologist consultation, spirometry, lower extremity vascular ultrasound, glycosylated haemoglobin (Hb1Ac), blood C-peptide, TSH blood test, ACTH blood test, cortisol blood test, acid-base blood test, and an electrolyte panel (K, Na, Cl, Ca).

Before the surgery, the patient was given saline laxatives 12 hours prior to the procedure. The patient also had the epidural space and central venous access catheterized. Antibiotic prophylaxis was administered, either with ertapenem at a dosage of 1 g per day for 5 days or with moxifloxacin at a dosage of 400 mg per day for 5 days. Additionally, low-molecular-weight heparins and enoxaparin at a dosage of 0.4 were administered 12 hours before the operation.

All patients underwent laparoscopic Roux-en-Y Gastric Bypass surgery. A laparoscopic gastric bypass procedure was performed by creating a cross-section of the small intestine at a distance of 50 cm from the ligament of Treitz using a stapler and a cutter (ETHICON ECHELON FLEX 60 (USA)) and a blue cassette (staples 3.8 mm in height). The formation of a "small" stomach with a volume of 20-30 ml was carried out using a stapler (ETHICON ECHELON FLEX 60 (USA)) and a green (staples 4.1 mm in height) and a yellow cassette (staples 3.9 mm in height).

A gastroenteroanastomosis was applied side-to-side between the "small" stomach and the alimentary loop of the small intestine. The back lip of the anastomosis was formed using a stapler (ETHICON ECHELON FLEX 45 (USA)) and a blue cassette (staples 3.8 mm in height). A continuous suture technique was employed to create the front lip of the anastomosis using atraumatic suture material (Vicril 3/0).

If the operation lasted more than 2 hours, the elimination of pneumoperitoneum for 10 minutes every 2 hours prevented rhabdomyolysis. Elastic compression of the lower extremities was performed for thromboprophylaxis. A nasogastric tube was installed for 3-4 days. The urinary catheter was removed one day after the operation. Abdominal cavity drainage was carried out using two drains. The average duration of a surgical intervention was 179.43 minutes. All patients received an intraoperative administration of a 40 mg proton pump inhibitor and 4 mg ondansetron.

In the postoperative period, all patients underwent elastic compression of the lower extremities; verticalization of the patient in the intensive care unit was conducted 6 hours after extubation; and a small saline enema was prescribed the next day after the operation. Low-molecular-weight heparins were administered once a day at 0.4 for 14 days. The drinking regimen was resumed on the 6th day during gastrography with liquid contrast to assess the failure of the gastroenteroanastomosis. Video esophagogastroscopy was performed, if necessary, in the presence of complaints. According to the scheme, all patients received PPIs at 20 mg twice a day within 30 days after the operation.

The research was conducted in accordance with modern principles of bioethics. Statistical analysis was performed using IBM SPSS Statistics Base software (version 26).

RESULTS

Approaches to the management of patients in the retrospective group in the pre-, intra-, and postoperative periods were analysed, with the aim of identifying risk factors for postoperative complications, in particular bleeding, and reducing their level in the future (Table 2).

The stepwise inclusion/exclusion of variables (Stepwise) method was used to select the minimum set of factor characteristics associated with the occurrence of bleeding in patients with MO after laparoscopic gastric bypass. Four factor characteristics associated with the probability of bleeding were identified: "number of comorbid conditions", "arterial hypertension", "chronic liver diseases" and "chronic obstructive pulmonary disease" (Table 3).

The findings of this study allowed us to develop a new strategy for managing patients with MO. This strategy

| <u> </u> | 5 1 | | 1 5 | 11 | 1 3 | | |
|---|---------------------------------|---------------|--------|---------------|--------------|---------------|--|
| Site of bleeding | Intraabdominal/ intraluminal | Age/ years | Sex | Weight/ kg | Height/ m | BMI kg/ m2 | Treatment |
| Marginal ulcer of gastroentero anastomosis | Intraluminal | 58 | Female | 152 | 1,79 | 47,4 | Conservative treatment |
| Short vessels of the stomach | Intraabdominal | 31 | Male | 145 | 1,8 | 44,7 | Relaparoscopy |
| Line of sutures in the area of gastroentero anastomosis | Intraluminal | 48 | Female | 154 | 1,78 | 48,6 | Endoscopic haemostasis |
| Line of sutures of the stomach remnant | Intraluminal | 49 | Male | 145 | 1,8 | 44,7 | Relaparoscopy. Gastrotomy. Blood clot removal. |
| Line of sutures of the stomach remnant | Intraluminal | 35 | Female | 152 | 1,81 | 46,4 | Relaparoscopy. Gastrotomy. Blood clot removal. |
| Marginal ulcer of gastroentero anastomosis | Intraluminal | 57 | Male | 142 | 1,78 | 44,8 | Conservative treatment |
| Marginal ulcer of gastroentero anastomosis | Intraluminal | 51 | Female | 168 | 1,71 | 57,5 | Conservative treatment |
| Line of sutures in the area of gastroentero anastomosis | Intraluminal | 37 | Male | 140 | 1,79 | 43,7 | Conservative treatment |

| | Table 1. Episodes o | f postoperative bleeding | g in patients with MO at | fter laparoscopic gastric by | pass (retrospective group) |
|--|---------------------|--------------------------|--------------------------|------------------------------|----------------------------|
|--|---------------------|--------------------------|--------------------------|------------------------------|----------------------------|

includes the implementation of the ERAS protocol guidelines and our clinical experience, and it consists of four stages: preoperative assessment as well as the pre-, intra-, and postoperative periods. 170 patients were enrolled in the prospective group for the period from 2019 to 2022. The group was comparable to the retrospective group in terms of age, sex, height, body weight, BMI, total number, and severity of comorbid conditions. Among them were 73 (42.9%) men and 97 (57.1%) women. The mean body weight was 145.7 (95% CI: 143.8–147.6) kg, and the mean body mass index (BMI) was 45.88 (95% CI: 45.14-46.63) kg/m2. The surgical and anaesthetic risk, as assessed by the ASA scale, was 3.3 (95%CI: 3.19-3.42). There were 3 episodes of postoperative bleeding, representing a rate of 1.76% (Table 4).

The preoperative assessment was not different from the retrospective group. Patients in the prospective group received the following preoperative preparations: saline laxatives 12 hours before surgery; catheterization of the epidural space and central venous access under ultrasound control; a carbohydrate mixture 4 hours before the start of the operation (5% 200 ml of glucose); dexamethasone 8 mg intravenously 10 minutes before the incision; and antibiotic prophylaxis 30 minutes before surgery.

In the prospective group, all operations were performed laparoscopically. Local infiltration anaesthesia of the areas where trocars were installed was added intraoperatively; instead of elastic compression, pneumocompression of the lower extremities was performed to prevent blood clot formation. The formation of a "small" stomach, enteroentero and gastroentero anastomoses was carried out using Tri Staple EGIA60AMT (staple height: 3 mm, 3.5 mm, 4 mm) and EGIA60AVM (2 mm, 2.5 mm, 3 mm) instead of the blue, green, and yellow ECHELON 60 STAPLER cassettes. Paracetamol was administered intravenously at the start of the skin suturing procedure. Tranexamic acid preparations of 5 ml were given to the prospective group at the end of the procedure, as well as 12 and 24 hours later.

After the operation, the urinary catheter was immediately removed; the nasogastric tube was removed within 1 day; and drains were removed 2-3 days after the operation.

The early activation of patients was carried out postoperatively. The drinking regimen was resumed 6 hours after the operation, with a gradual increase in the liquid volume and a decrease in infusion therapy. On the 4th day, all patients who did not have any complications underwent contrast gastrography to assess the capacity of gastroentero anastomosis. A video esophagogastroscopy was indicated in the presence of complaints, and a 6-month course of proton pump inhibitors (20 mg twice a day) was administered (Table 5).

DISCUSSION

Modifications are required in the management of morbidly obese patients who have undergone laparoscopic gastric bypass surgery in order to decrease postoperative complications and enhance the quality of life of patients during the perioperative period.

| Factor sign | The value of the coefficient of the model, b±m _b | Significance difference of the coefficient from 0, p | Area under the ROC curve of the model, AUC (95% CI) | Odds ratio indicator of the model, OD (95% CI) | Significance difference of the OD from 0, p |
|---|---|--|---|--|---|
| Age, years | 0,13±0,01 | 0,01 | 0,78 (0,61-0,94) | 1,14 (1,02-1,28) | 0,01 |
| Sex (1 – male, 2 – female) | 0,46±0,74 | 0,53 | 0,56 (0,48–0,63) | 1,59 (0,37–6,86) | 0,53 |
| Weight, kg | 0,02±0,02 | 0,32 | 0,63 (0,56–0,71) | 1,02 (0,98–1,07) | 0,32 |
| Height, sm | 5,16±4,44 | 0,24 | 0,62 (0,54-0,69) | 174,61(0,03-1058055,75) | 0,24 |
| BMI, kg/m ² | 0,002±0,07 | 0,97 | 0,52 (0,44-0,59) | 1,00(0,87-1,15) | 0,97 |
| Time of operation, min | 0,04±0,03 | 0,13 | 0,66 (0,58-0,73) | 1,05 (0,98-1,12) | 0,13 |
| ASA, class | 0,02±0,47 | 0,95 | 0,52 (0,44-0,59) | 1,02(0,4-2,62) | 0,95 |
| Number of comorbidities, n | 1,37±0,46 | 0,003 | 0,85(0,79-0,9) | 3,94(1,57-9,82) | 0,003 |
| Chronic obstructive lung disease (1 –yes, 0 – no) | 0,93±0,39 | 0,01 | 0,69(0,62-0,76) | 2,53(1,16-5,5) | 0,01 |
| Chronic liver disease (1 –yes, 0 – no) | 2,02±0,58 | 0,0006 | 0,86(0,66-1,00) | 7,6(2,4-24,04) | 0,0006 |
| Arterial hypertension, (1 –yes, 0 – no) | 0,91±0,42 | 0,03 | 0,72(0,65-0,78) | 2,5(1,09-5,7) | 0.03 |
| Diabetes mellitus, (1 –yes, 0 – no) | -0,93±0,72 | 0,19 | 0,55(0,31-0,8) | 0,39(0,09-1,63) | 0,19 |
| Alcohol consumption (1 –yes, 0 – no), | -0,11±0,72 | 0,87 | 0,51(0,43-0,59) | 0,88(0,21-3,67) | 0,87 |
| GERD, (1 –yes, 0 – no) | -0,62±0,74 | 0,39 | 0,72(0,48-0,96) | 0,53(0,12-2,3) | 0,39 |
| Ability to move independently (1 – yes, 0 – no) | -0,82±1,11 | 0,45 | 0,53(0,45-0,6) | 0,43(0,04-3,91) | 0,45 |
| Myocardial infarction in medical history, (1 –yes, 0 – no) | -19,84±7521,56 | 0,33 | 0,56(0,36-0,75) | 2,4(0,31-5,8) | 0,33 |
| Deep vein thrombosis, (1 –yes, 0 – no) | 1,17±0,72 | 0,1 | 0,63 (0,55-0,7) | 3,25(0,77-13,5) | 0,1 |
| Chronic venous insufficiency, (1 –yes, 0 – no) | -0,54±0,75 | 0,47 | 0,55(0,48-0,63) | 0,58(0,13-2,53) | 0,47 |
| Cholecystectomy during surgery, (1 –yes, 0 – no) | -1,31±1,08 | 0,22 | 0,61(0,53-0,68) | 0,26(0,032-2,23) | 0,22 |
| Duration of drains, days | 0,46±0,51 | 0,36 | 0,58(0,51-0,66) | 1,58(0,57-4,34) | 0,36 |
| Duration of the nasogastric tube, days | 0,79±0,48 | 0,1 | 0,65(0,57-0,72) | 2,22(0,85-5,76) | 0,1 |
| Gastrography, day | 0,41±0,74 | 0,57 | 0,55(0,47-0,62) | 1,51(0,35-6,54) | 0,57 |
| Administration of tranexamic acid, (1 -yes, 0 - no) | 0,81±0,74 | 0,27 | 0,6(0,52-0,67) | 2,26(0,52-9,8) | 0,27 |
| Level of discomfort from drains, probe, urinary catheter, points | 0,38±0,33 | 0,25 | 0,61(0,53-0,68) | 1,46(0,75-2,83) | 0,25 |

| Table 2. Analy | vsis of univariate log | istic rearession mo | dels of bleeding | episodes in | patients with MO in the | postoperative | period after lapa | aroscopic gastric by | bass |
|----------------|------------------------|---------------------|------------------|-------------|-------------------------|---------------|-------------------|----------------------|------|
| | | | | | | | | | 6 |

Table 3. Analysis of the multivariate logistic regression model of bleeding episodes in patients with MO in the postoperative period after laparoscopic gastric bypass

| Factor sign | The value of the coefficient of the model, b±m _b | Significance difference of the coefficient from 0, p | Odds ratio indicator of the model, OD (95% CI) |
|--|---|--|---|
| Number of comorbidity, n | 0,347±0,04 | <0,0001 | 0,078(0.006-0.988) |
| Arterial hypertension, (1 –yes, 0 – no) | 0,038±0,01 | <0,0001 | 443,0(1,42-13900,0) |
| Chronic liver disease (1 –yes, 0 – no) | 0,049±0,01 | <0,0001 | 81,7(2,34-2850,0) |
| Chronic obstructive lung disease (1 -yes, 0 - no) | 0,031±0,01 | 0,01 | 41,3(1,08-139,0) |

Table 4. Episode of postoperative bleeding in a patient with MO after laparoscopic gastric bypass (prospective group)

| Site of bleeding | Intraabdominal/ intraluminal | Age/ years | Sex | Weight/ kg | Height/ m | BMI kg/ m² | Treatment |
|---|---------------------------------|---------------|--------|---------------|--------------|---------------|--------------|
| Line of sutures in the area of gastroentero anastomosis | Intraluminal | 49 | Female | 167 | 1,76 | 53,91 | Conservative |
| Marginal ulcer of gastroentero anastomosis | Intraluminal | 55 | Male | 141 | 1,84 | 44,6 | Conservative |
| Line of sutures in the area of gastroentero anastomosis | Intraluminal | 52 | Female | 141 | 1,8 | 43,52 | Conservative |

Table 5. Comparison of the main indicators in the retrospective and prospective groups

| Indicators | Retrospective group | Prospective group | р |
|--|---------------------|-------------------|--------|
| Age, years | 44,79±8,46 | 44,83±8,55 | 0,96 |
| Sex (1 – male, 2 – female) | 1,51±0,5 | 1,57±0,49 | 0,318 |
| Weight, kg | 144,8±13,93 | 145,7±12,55 | 0,516 |
| Height, sm | 1,78±0,08 | 1,78±0,07 | 0,749 |
| BMI, kg/m² | 45,44±5,23 | 45,88±4,92 | 0,424 |
| Time of operation, min | 179,4±16,44 | 139,2±8,93 | <0,001 |
| ASA, class | 3,36±0,76 | 3,30±0,75 | 0,510 |
| Number of comorbidity, n | 8,86±1,88 | 8,39±2,11 | 0,068 |
| Chronic obstructive lung disease (1 –yes, 0 – no) | 1,06±0,93 | 1,05±0,88 | 0,928 |
| Chronic liver disease (1 –yes, 0 – no) | 1,21±0,9 | 1,18±0,86 | 0,787 |
| Arterial hypertension, (1 –yes, 0 – no) | 1,365±0,95 | 1,341±0,93 | 0,81 |
| Diabetes mellitus, (1 –yes, 0 – no) | 0,7±0,12 | 0,67±0,47 | 0,454 |
| Alcohol consumption (1 –yes, 0 – no), | 0,52±0,5 | 0,42±0,49 | 0,065 |
| GERD, (1 –yes, 0 – no) | 0,47±0,32 | 0,38±0,48 | 0,062 |
| Ability to move independently (1 –yes, 0 – no) | 0,93±0,24 | 0,92±0,26 | 0,590 |
| Myocardial infarction in medical history, (1 –yes, 0 – no) | 0,24±0,42 | 0,2±0,4 | 0,353 |
| Deep vein thrombosis, (1 –yes, 0 – no) | 0,24±0,43 | 0,22±0,41 | 0,603 |
| Chronic venous insufficiency, (1 –yes, 0 – no) | 0,73±0,44 | 0,67±0,46 | 0,223 |
| Cholecystectomy during surgery, (1 –yes, 0 – no) | 0,33±0,47 | 0,28±0,45 | 0,328 |
| Duration of drains, days | 5,27±0,74 | 1,28±0,64 | <0,001 |
| Duration of the nasogastric tube, days | 4,00±0,84 | 1,06±0,51 | <0,001 |
| Gastrography, day | 5,52±0,50 | 3,34±0,55 | <0,001 |
| Level of discomfort from drains, probe, urinary catheter, points | 5,51±1,20 | 3,26±0,61 | <0,001 |
| Number of bleeding, n | 8 | 3 | < 0,05 |

Given the rather high incidence of bleeding following laparoscopic gastric bypass (0.5–5.8%) [6] and based on the findings of two research groups, we created a set of measures aimed at minimising postoperative bleeding episodes.

According to Sharma G. et al. (2016), the most frequent locations of bleeding are the gastroenteroanastomotic suture line (56%), and the enteroenteroanastomotic suture line (11%) [7]. Therefore, an important stage of the research was the comparison of two types of cassettes, ECHELON 60 STAPLER (retrospective group) and Tri Staple (prospective group), to study their effect on the occurrence of bleeding. The peculiarity of the Tri Staple technique is that the staples are arranged in three rows. Each row has a different height. This contributes to a greater chance of suturing all layers of the wall of the stomach or intestine and provides better tissue perfusion. For ECHELON 60 STAPLER cassettes, where the staples have the same height, achieving this effect is more difficult [8-10].

In addition, we added 5 ml of tranexamic acid to the therapy protocol at the stage of skin suturing, as well as 12 and 24 hours afterwards. The drug was given to all 170 patients in the prospective group and to 77 patients (43.3%) in the retrospective group.

According to various studies, long-term use of a nasogastric tube and urinary catheter increases the risk of complications associated with them and significantly reduces the quality of life [11,12]. After analysing a retrospective group, we concluded that the prolonged use of nasogastric tubes, drains, and urinary catheters, as well as delayed resumption of drinking, do not contribute to bleeding. Therefore, we made modifications to these practices for the patient's benefit. Based on VAS pain scale data, drains, nasogastric tubes, urinary catheters, and lack of drinking caused discomfort at a level of 5.51 ± 1.2 . Therefore, taking into account that bleeding most often occurs during the first 24 hours, for the prospective group, in the absence of complications, the nasogastric tube, urinary catheter, and drainage were removed 24 hours after the operation. This reduced the level of discomfort on the VAS scale to 3.24 ± 0.42 .

The application of multimodal anaesthesia as part of the ERAS protocol is proven, so the administration of Paracetamol probably reduces the pain syndrome, which can also have an impact on the frequency of bleeding. Installation of the epidural catheter was carried out under ultrasound control, which is more accurate and safer, contributes to the effectiveness of analgesia, and probably influences the rate of complications [13-15].

CONCLUSIONS

The factors responsible for the occurrence of postoperative bleeding in morbidly obese patients after laparoscopic gastric bypass surgery were identified. They include the number of comorbid conditions, the presence of arterial hypertension, the presence of chronic liver diseases, and chronic obstructive pulmonary disease. A new strategy for the management of morbidly obese patients after laparoscopic gastric bypass was developed. This strategy involves changing cassettes to create gastroentero and enteroenteroanastomoses, reducing the period of use of the nasogastric tube, drains, and urinary catheter from 3-4 days to 1 day, and resuming the drinking regimen 6 hours after extubation. The implementation of the new strategy led to a decrease in postoperative bleeding from 4.49% to 1.76% (*P* < 0.05).

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Victor O. Nevmerzhytskyi Bogomolets National Medical University 13 T. Shevchenko blvd. 01601 Kyiv, Ukraine

e-mail: vnsurgeon@ukr.net

ORCID AND CONTRIBUTIONSHIP

Oleksander Y. loffe: 0000-0002-1306-7920 A F Victor O. Nevmerzhytskyi: 0000-0003-1427-9498 A B C D Mykola S. Kryvopustov: 0000-0003-4978-4873 A B C Yurii P. Tsiura: 0000-0001-6651-8564 A D Taras M. Galyga: 0000-0001-5150-0038 E Stepan L. Kindzer: 0000-0002-4136-9299 B Vladislav M. Perepadya: 0000-0003-2188-424X E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔽

Interleukin-17 as predictor mortality of septic patients: a systematic review and meta-analysis

Dwi Retnoningrum¹, Budi Mulyono², Umi Solekhah Intansari², Ardhea Jaludamascena³ ¹UNIVERSITAS DIPONEGORO, SEMARANG, INDONESIA ²GADJAH MADA UNIVERSITY, BULAKSUMUR, INDONESIA ³ DR. KARIADI HOSPITAL, SEMARANG, INDONESIA

ABSTRACT

Aim: This study aimed to prove the role of IL-17 on the clinical outcomes of septic patients.

Materials and Methods: This study used a systematic review and meta-analysis design. Data were obtained by searching articles published between January 2001 and June 2022 in Pubmed, Science Direct, Scopus, and Medline databases to evaluate Interleukin-17 on clinical outcomes in septic patients. Only human studies were used in this study. Meta-analysis was undertaken using random effects models.

Results: Fourteen published studies were eligible, and four studies were included in the meta-analysis. Meta-analysis of the ratio of means (RoM) IL-17 concentration demonstrated a 5.96-fold higher level in non-survivor septic patients compared with survivors (four studies; n = 194 patients; RoM=5.96; 95% Cl, 3.51-10.31; p < 0.00001; $l^2 = 92\%$).

Conclusions: IL-17 levels were significantly elevated in non-survivor and predicted mortality of septic patients.

KEY WORDS: Cytokine, Interleukin-17, sepsis

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INTRODUCTION

Sepsis is a syndrome that occurs in patients with systemic infection and often happens in critically ill patients. Thus, it requires appropriate markers and initial therapy to reduce its mortality rate. The mortality of sepsis varies between 25-30% of sepsis and 40-50% of septic shock [1,2]. The incidence of sepsis in the United States is around 300 cases per 100.000 population, of which 50% are undergoing treatment in Intensive Care Units[3]. The epidemiological trend of sepsis in Spain shows that the incidence of sepsis has increased from 3.3 per 1000 population in 2000 to 4.45 in 2013, with an increase in mortality from 6.34 to 7.89 per 1,000 population [4]. A 2009 study conducted by Phua et al, from 150 intensive care units in 16 countries in Asia, showed that severe sepsis was diagnosed in 10.9% of intensive care patients, with a mortality rate of 44.5% [5].

The pathogenesis of sepsis begins with the presence of infectious agents that enter blood circulation causing a systemic inflammatory state, but the presence of pathogens in the systemic circulation is not always present in cases of sepsis, the presence of inflammatory mediators released systemically can induce sepsis. While sepsis can be caused by various infectious agents, including bacteria, fungi, parasites, and viruses [6]. A study conducted by Vincent et al, in patients with infections in intensive care units (ICU), found that 70% of infection cases with positive culture results were 62% caused by Gram-negative bacteria, 47% by Gram-positive bacteria, and 19% by fungal infections [7].

Interleukin-17 is a pro-inflammatory cytokine produced by T helper-17, Natural Killer (NK) cells, CD-8 T cells, and neutrophils. IL-17 increases chemokine production which plays a major role in the recruitment of monocytes and neutrophils to the site of inflammation. This shows the important role of IL-17 as a proinflammatory cytokine in infectious conditions. Early studies of sepsis induction in animals demonstrated a distinct role for IL-17 [8,9]. Several systematic reviews and meta-analyses of IL-17 have been conducted on autoimmune diseases [10, 11]. Thus far, the researchers have not been able to find systematic review studies of IL-17 on sepsis that has been published, so the researchers want to conduct a systematic review and meta-analysis of the role of IL-17 in clinical outcomes in sepsis.

| Study (years) | Countries | Total subjects | Age (years) | Gender (male)% |
|---------------------------------|-----------|-------------------|------------------|-------------------|
| Akin et al. 2015 (18) | Turkey | 94 | 63 (19-87) | 57 (60.6) |
| Ali et al. 2017 (19) | Egypt | 100 | 32 (22-48) | 80 (80) |
| Angurana et al. 2020 (20) | India | 50 | 3.4 (0.95-7) | 30 (60) |
| Bozza et al. 2007 (21) | Brazil | 60 | 64 (51-75) | 36 (60) |
| Chen et al. 2021 (22) | China | 157 | 56.2±12.3 | 94 (59.9) |
| Dai et al. 2015 (23) | China | 18 | 49.5 (28-67) | 8 (44.4) |
| Guo et al. 2017(24) | China | 48 | 50.6 ±11.9 | 30 (62.5) |
| Huang et al. 2016 (25) | Taiwan | 76 | 71.3 ± 2.3 | 49 (64.5) |
| Lee et al. 2016 (26) | Korea | 212 | 67.5 (29-95) | 149 (70.3) |
| Liu et al. 2020 (27) | China | 210 | 56.1 ± 12.3 | 145 (69.0) |
| Mikacenic et al. 2016 (28) | USA | 140 | 54 ± 16 | 104 (74) |
| Na et al. 2019 (29) | China | 219 | 56.5 ± 10.3 | 143 (65.3) |
| Rendon-Ramirez et al. 2015 (30) | Mexico | 29 | 37.68 (± 11.56) | 12 (41.4) |
| Wang et al. 2022 (31) | China | 78 | 56.6 ± 11.4 | 49 (62.8) |
| White et al. 2010 (32) | Ireland | 59 | 54 (72–80) | 32 (54.2) |
| Wu et al. a 2015 (33) | Taiwan | 52 | 72.31 ± 1.72 | 28 (54) |
| Wu et al. b 2011(34) | Taiwan | 35 | 73.0 ± 3.2 | 24 (68.6) |
| | | | | |

Table 1. Characteristic data of the study

AIM

This study aimed to prove the role of IL-17 on the clinical outcomes of septic patients.

MATERIALS AND METHODS

This study was a systematic review and meta-analysis, which evaluated interleukin-17 on the clinical outcomes of sepsis patients. The researchers referred to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) flow diagram to search articles [12, 13]. While duplication of the same articles was detected using the Mendeley desktop software application [14]. The protocol was registered into the PROSPERO International Prospective Register of Systematic Reviews (Prospero) database (Registration number: CRD42022323950).

SEARCH STRATEGY

Literature searches were conducted on several databases: PubMed, ScienceDirect, Medline, and Scopus. This systematic review and meta-analysis used articles published from January 2001 to June 2022. Patient, intervention, comparison, and outcome (PICO) framework was used to facilitate the search strategy, with P: Sepsis OR Septic patients, I: Interleukin-17 OR IL-17, C: No comparison, and O: Mortality. Selected keywords such as "Interleukin-17" OR "IL-17" AND "sepsis" OR "septic" were used.

ELIGIBILITY CRITERIA

The inclusion criteria were 1) Articles written in English and were available in full-texts, 2) a study design that reported a prospective cohort with outcome assessment (survivors and non-survivors), and 3) measure serum or plasma IL-17 levels. The exclusion criteria were articles with experimental animal studies.

DATA EXTRACTION

Data extraction was made by summarizing the articles including the names of the researchers (years of publication of the articles), countries, study designs,

| Study (year) | Specimen | Method | Sampling collection (hours) | Total sample | Outcome measurement | N Survivor | N Non-survivor | lL-17 Survivor (pg/ml) | IL-17 Non- survivor (pg/mL) |
|--------------------------------|----------|--------------------|-----------------------------------|-----------------|------------------------|---------------|-------------------|------------------------------|-----------------------------------|
| Akin et al (2015) | serum | ELISA | <12 | 94 | 28 days | 64 | 30 | 0 (0-611.6) | 11.3 (0-328.9) |
| Ali et al (2017) | serum | ELISA | 3 | 100 | 28 days | 84 | 16 | NR | NR |
| Angurana et al (2020) | serum | ELISA | 12 | 50 | NR | 45 | 5 | 237 (122-318) | 400 (333-563) |
| Bozza et al (2007) | plasma | Bio-plex system | <24 | 60 | 28 days | 31 | 29 | 0.0 (0.0-0.0) | 0.0 (0.0-0.2) |
| Chen et al (2021) | serum | ELISA | <24 | 157 | 28 days | 125 | 32 | NR | NR |
| Dai et al (2015) | serum | ELISA | <24 | 18 | 28 days | 15 | 3 | 186.4 ±110.7 | 308.1 ± 175.3 |
| Guo et al (2017) | plasma | ELISA | 6 | 48 | 28 days | 36 | 12 | 36.0 ± 13.7 | 54.0±15.3 |
| Huang et al (2016) | plasma | ELISA | <24 | 76 | 28 days | 54 | 22 | 8.1 ± 2.6 | 19.3 ± 8.9 |
| Lee et al (2016) | serum | ELISA | <24 | 212 | 28 days | 155 | 57 | 6.8 (1.8-317.1) | 5.3 (1.9-91.2) |
| Liu et al (2020) | serum | ELISA | <24 | 210 | 28 days | 172 | 38 | NR | NR |
| Mikacenic et al (2016) | plasma | CLIA | <24 | 140 | 28 days | 114 | 26 | NR | NR |
| Na et al (2019) | plasma | ELISA | <24 | 219 | 28 days | 163 | 56 | NR | NR |
| Rendon-Ramirez et al (2015) | serum | Milliplex MAP | <24 | 29 | 28 days | 13 | 16 | NR | NR |
| Wang et al (2022) | serum | ELISA | <24 | 78 | 28 days | 63 | 15 | NR | NR |
| White et al (2010) | serum | ELISA | <24 | 59 | NR | 41 | 18 | 31 (20.4–31) | 25.7 (18.2–38.5) |
| Wu et al a (2015) | plasma | ELISA | <48 | 52 | 28 days | 38 | 14 | 3.12 ± 1.06 | 4.85 ± 3.01 |
| Wu et al b (2011) | plasma | ELISA | <48 | 35 | 28 days | 23 | 12 | 8.7 (0.0 -131.6) | 14.4 (0.0 -197.0) |

| Table 2. | Interleukin-17 | level and | outcome | measurement |
|------------|----------------|-----------|---------|---------------|
| 1 a vic 2. | | icver and | outcome | Incasulcincin |

NR: not reported.

patient demographics, and IL-17 levels. The summary of the research articles was tabulated alphabetically. The article summary was analyzed for IL-17 measurements and patient clinical outcomes (survivors versus non-survivors) in the study objectives and results.

Nominal variable data were presented as a proportion by percentage, whereas continuous data were presented as mean \pm SD (standard deviation), median interquartile range (IQR), or range (minimum-maximum). The results were described in quantitative and qualitative summaries. In this study, the heterogeneity test was found to be less than 0.05 or large I² so the analysis model used was the random effects model (REM). Continuous data were calculated as a ratio of means (RoM) for each study and a meta-analysis was carried out using the generic inverse variance method (DerSimonian and Laird) to produce pooled measures of association, with 95% confidence interval (95% CI) and forest plots[15].

STATISTICAL ANALYSIS

Statistics with a significance of 0.05 and a confidence interval, and statistical heterogeneity used the l² statistic. Data analysis used Microsoft Excel and Review Manager version 5.4 [16]. Risk of bias assessment was performed using Quality in Prognostic Studies (QUIPS) to assess cohort studies for the association of IL-17 levels with clinical outcome (survivor vs non-survivor)[17].

RESULTS

The flow of research selection is presented in Fig. 1. The articles that belong to the inclusion and exclusion criteria for qualitative synthesis were 17 articles, and 4 articles were followed by meta-analysis.

The characteristics of each study are presented in Table 1. The results of the qualitative analysis of the 17 studies showed that the number of subjects was 1637 sepsis patients. One study (Angurana et al) was a study with the subject of sepsis in children, while the others had adult sepsis patients as their subjects. The IL-17 examination carried out in the research method of each study mostly used the Enzyme-linked immunosorbent assay (ELISA) method in 14 studies. One study with the Chemiluminescence immunoassay (CLIA) method (28)







Fig.1. The PRISMA flow diagram.

Fig. 2. Forest plot of IL-17 in survivor vs non-survivor.



acute respiratory distress syndrome 1, two studies used the multiplex immunoassay system (21,30). Fifteen of the 17 sampling studies were undertaken for less than 24 hours during the treatment period, while 2 studies less than 48 hours. Survivor and non-survivor status for the majority of the study were followed within 28 days of treatment (88.2%). Seven studies did not obtain data on IL-17 levels between survivors and non-survivors, and 6 studies did not present the mean ± SD so 13 studies could not be continued to be quantitatively analyzed by meta-analysis (Table 2).

Based on the clinical outcome of patients with sepsis after 28 days of treatment, it was found that patients with 28 days of death (non-survivors) had higher IL-17 levels of 5.96 times compared to patients who were alive (survivors) (4 studies; n=194 patients; RoM = 5.96; 95% CI, 3.51-10.13; p <0.00001; I2 = 92%). The results were presented on the Forest plot (Fig. 2) as the result of a combined line when each study was plotted in one axis, the results of the log Ratio of Means (RoM), standard error (SE), and weight of each study were described. After a meta-analysis of the heterogeneity test, it was found that the p-value was <0.00001 with I² 92% which indicates that there was large heterogeneity between studies (subgroups).

Assessment of risk of bias was carried out using Quality in Prognostic Studies (QUIPS) to assess cohort studies for the association of IL-17 levels with clinical outcomes (survivors and non-survivors)[17]. Based on the assessment of the risk of bias in each study, it was found that 6 studies had a high risk of bias, 6 studies had moderate bias and 5 studies had a low risk. The risk analysis for bias is shown in Fig. 3.

DISCUSSION

Most of the patients in each study were males. This was consistent with several other studies which showed a higher percentage of sepsis in males, 55% in the Shankar-Hari et al, 63% in the Lie et al, and 60.1% in the Sakr et al[18-20]. Most studies with adult sepsis patients occur at an older age because more comorbidities increased morbidity and mortality in sepsis. Alvaro-Meca et al, reported in an epidemiological study of sepsis in Spain that the incidence and mortality of sepsis increased in old age (50-59 years), increased at the age of 65 years, and was highest in the elderly over 85 years. The case fatality rate (CFR) in children was 7.2%, increasing to 20% at the age of 45-49 years and 30% at the age of 65 years[4].

The IL-17 levels from the meta-analysis found that non-survivor patients were 5.96 times higher than in survivors. The mechanism of high IL-17 in septic patients remained unknown. Interleukin-17 plays an important role in defense against bacteria produced by T cells, neutrophils, and some other cells by increasing the production of chemokines which play a role in the recruitment of neutrophils and monocytes to the tissue of the infection site. In addition, IL-17 plays a role in the production of other proinflammatory cytokines. Several animal studies have shown susceptibility to sepsis in states of IL-17 deficiency. However, this systematic review shows that elevated levels of IL-17 were associated with mortality in septic patients. The important role of IL-17 in the inflammatory response is the mobilization of neutrophils to the site of infection and the induction of the release of other proinflammatory cytokines. This is an important defense against infection with microorganisms [21].

Neutrophils are considered part of the first line of the immune system. Neutrophils can be found in the bloodstream, with a lifespan of 6-8 hours, and in tissues, that can last up to 7 days. The mechanisms that neutrophils use for host defense are phagocytosis, degranulation, cytokine production, and, most recently described, the production of neutrophil extracellular trap (NET). NETs are DNA structures that are released due to the decondensation and dispersal of chromatin, and thus occupy three to five times the volume of condensed chromatin. Several proteins attach to the NET, including histones and more than 30 primary and secondary granular components, including components with bactericidal activity such as elastase, myeloperoxidase, cathepsin G, lactoferrin, pentraxin 3, gelatinase, proteinase 3, LL37, peptidoglycan-binding protein, and others with bactericidal activity capable of destroying virulence factors [21]. Mobilization of neutrophils to the site of infection causes NETosis which can affect the clinical outcome of sepsis.

Increased levels of IL-17 as a proinflammatory cytokine excess caused hyperinflammatory conditions and a poor prognosis in the survival of patients with sepsis. Akin et al study reported an association of IL-17 with other markers of inflammation, IL-17 was associated with TNFa (p < 0.001, r = 0.39), C-reactive protein (p =0.014), and procalcitonin levels (p = 0.011)[18]. High levels of IL-17 in sepsis and there are research results showing that non-survivors had high levels of IL-17 in less than 48 hours of the initial examination of patients with sepsis provided an overview as a prognostic factor in patients with sepsis to the stage of severe sepsis or the occurrence of MODS. Examination of IL-17 levels in septic patients was expected to assist in determining therapeutic management to reduce patient morbidity to severe conditions or mortality in septic patients.

There were several limitations to this systematic review and meta-analysis study. The research was

obtained only from the database of international publications in English, while the unpublished studies or gray literature were not searched for data sources. The method of IL-17 examination was not entirely the same so it could cause examination bias. The etiology and severity of sepsis were not the same and might affect clinical outcomes.

CONCLUSIONS

Interleukin-17 was significantly higher in non-survivor sepsis patients than in survivor patients. Further research is needed to include the gray literature and in various languages. Measurement of IL-17 with a standardized method and the severity of sepsis should be considered in future studies.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Dwi Retnoningrum Universitas Diponegoro Semarang City, Central Java, Indonesia e-mail: dwiretno@fk.undip.ac.id

ORCID AND CONTRIBUTIONSHIP

Dwi Retnoningrum: 0000-0003-1606-0078 (A) (B) (C) (D) Budi Mulyono: 0000-0002-0153-6427 (E) (F) Umi Solekhah Intansari: 0000-0003-0646-4781 (A) (E) (F) Ardhea Jaludamascena: 0009-0003-6744-0553 (B) (C) (D)

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ORIGINAL ARTICLE

CONTENTS 🔼

The impact of negative factors of professional activities on the health of law enforcement officers

Ivan M. Okhrimenko¹, Igor V. Ozerskyi², Liudmyla V. Levytska³, Natalia H. Ivanova⁴, Yurii A. Ivanov⁴

¹NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE

²PETRO MOHYLA BLACK SEA NATIONAL UNIVERSITY, MYKOLAIV, UKRAINE

³ BOHDAN KHMELNYTSKYI NATIONAL ACADEMY OF THE STATE BORDER GUARD SERVICE OF UKRAINE, KHMELNYTSKYI, UKRAINE

⁴NATIONAL ACADEMY OF THE SECURITY SERVICE OF UKRAINE, KYIV, UKRAINE

ABSTRACT

Aim: To study the study the impact of negative factors of professional activities on the health of law enforcement officers.

Materials and Methods: The research involved 89 law enforcement officers (58 men, and 31 women) who served for a year in practical police units after graduating from a higher educational institution. Methods: analysis and generalization of scientific and methodological literature, anthropometry, physiometry, testing, and statistical methods. The health status was assessed by body mass index, Robinson index, and vital index.

Results: It was found that the body mass index of law enforcement officers for one year of service in practical units deteriorated in both men and women by 1.3 kg/m² and 0.9 kg/m², respectively. More negative changes were observed in men. At the same time, after one year of service, the number of men with overweight (27.5 %) and even obesity of the first (13.9 %) and second (5.2 %) degrees increased significantly. In women, the changes were less pronounced. The dynamics of Robinson and vital indices, as well as the level of physical fitness, were also negative.

Conclusions: The results of the research indicate a negative impact of professional factors in terms of professional activities on the health of law enforcement officers. It has been found that adherence to the principles of a healthy lifestyle, in particular, a regimen of rationally organized motor activity, is an important area in combating the impact of negative factors of professional activities on the health of law enforcement officers.

KEY WORDS: health, professional activity, law enforcement officers, negative factors

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INTRODUCTION

Any professional activity has its peculiarities, its specifics and is accompanied by the influence of several negative factors. Police service is a complex type of professional activity, which is characterized by increased responsibility for professional mistakes, the presence of authority, a high level of mental stress and overload in the course of service activities, the presence of extreme service situations, the fulfillment of which is associated with danger to the life of a police officer, the likelihood of harm to citizens in the course of professional activities, the aggressiveness of the criminal environment, unregulated diet, rest, sleep, motor activity, and other factors [1]. It is difficult for graduates of higher educational institutions with specific learning environment (HEI SLE) to adapt to new and unusual conditions of service as officers in the National Police. This problem has become especially pronounced since the beginning of the full-scale invasion of Ukraine by russian invaders, which has significantly worsened the mental state of the population, and increased the level of anxiety, depression, etc. [2]. Scientists [3, 4] identify several negative factors that accompany law enforcement officers' service activities in modern conditions: the need to make decisions that will significantly affect the fate of other people, which requires not only knowledge of numerous legal documents but also the ability to interpret them correctly and apply them promptly. This imposes on law enforcement officers external (from disciplinary to criminal) and internal responsibility for their actions; the need to perform professional actions and solve problems in a limited period, often in conditions of time pressure or conditions of a large number of simultaneous tasks; "inexhaustibility" of the goals of the activity, the fundamental impossibility of gaining success in work by achieving its goals (it is impossible to "fight crime"). Therefore, operating results are often replaced by imitation (indicators, reports, etc.); unexpectedness, sudden emergence of new urgent tasks, and new important information (at any time of the day,

day of the week, etc.). This results in irregular working hours of law enforcement officers, their involvement in the performance of service duties beyond the working day; the presence of elements of risk and danger to the life and health of law enforcement officers and their family members; tense professional communication with either "bad" people (criminals, lumpenized citizens, etc.) or "good" people in bad conditions (victims, witnesses, etc.); negative attitudes of citizens, low legal culture, their unrealistically high expectations of the government in general and negative attitudes towards police officers. All of these negative factors hurt the health (both physical and mental) of law enforcement officers [5, 6]. This is especially true for police officers who have recently graduated from HEIs SLE, where all their activities were regulated by daily routines and orders from commanders. After graduation from HEIs SLE and being assigned to practical police units, young officers face many difficulties related to the performance of professional duties and the organization of their own lives and household activities. The study of the impact of negative factors of law enforcement officers' professional activities on their health status to find effective ways to solve this problem led to the choice of the topic of this work.

AIM

The aim is to study the study the impact of negative factors of professional activities on the health of law enforcement officers.

MATERIALS AND METHODS

The research was conducted in 2023-2024 at National Academy of Internal Affairs (NAIA). The research involved 89 NAIA graduates of 2023 who received a bachelor's degree in the specialty 262 "Law Enforcement" and entered the NAIA for a master's degree one year later (58 men, 31 women). After graduation from the HEI SLE, all law enforcement officers served in practical police units with a pronounced impact of negative factors of professional activities on their health. The research was conducted in two stages: the first in 2023, and the second in 2024.

Methods: analysis and generalization of scientific and methodological literature, anthropometry, physiometry, testing, and statistical methods. The health status of law enforcement officers was assessed by body mass index (BMI characterizing the harmony of body structure and composition), Robinson index (RI characterizing the state of the cardiovascular system), and vital index (VI characterizing the state of the respiratory system). In addition, the comparative analysis of the scores for the following physical exercises performed by law enforcement officers before graduation and after one year of their service was conducted: 100 m run (males, females), pull-ups (males), push-ups (females), 1 km run (males, females). To assess the reliability of changes in law enforcement officers' health indicators, the Student's t-test was used. Statistical analysis was performed using STATISTICA 10 software. The research was carried out according to the requirements of the Code of Ethics of the NAIA and regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all individuals who took part in this research.

RESULTS

The comparative analysis of the BMI in law enforcement officers showed that over one year of service in practical units, both men's and women's indicators deteriorated (Table 1). More negative changes were observed in men; the difference between the indicators for 2023 and 2024 in men was 1.3 kg/m² and was significant ($p \le 0.05$), and in women – 0.9 kg/m² and it was not significant (p > 0.05).

The detailed analysis of the BMI in law enforcement officers before and one year after graduation from the HEI SLE showed that in 2023, the BMI in most men (89.6 %) and women (87.0 %) was within the age norm (18.5-24.9 kg/m²) (Table 2).

After one year of service, the number of male law enforcement officers with a normal BMI decreased to 53.4 %. In contrast, the number of overweight (27.5 %) and even obesity of the first degree (13.9 %) and obesity of the second degree (5.2 %) increased significantly. In women, changes in BMI levels were less pronounced: the number of overweight women increased to 16.1 %, and the number of women with obesity of the first degree increased to 3.2 %. This indicates that the factors of professional activities have a more pronounced negative impact on male law enforcement officers.

Studies of Robinson and vital indices showed negative dynamics for both men and women during one year of service in practical police units. The RI significantly deteriorated in men by 7.7 c. u. ($p \le 0.001$) and in women by 5.2 c. u. ($p \le 0.05$); the VI – by 5.3 ml/kg ($p \le 0.01$) in men and by 3.8 ml/kg ($p \le 0.05$) in women.

We also conducted the comparative analysis of the scores for physical fitness tests of law enforcement officers before and one year after graduation from the HEI SLE in three exercises (Table 3).

It was found that during one year of service, the level of physical fitness of both men and women deterio-

| Hoolth indicators — | Years of | research | - The difference | Poliobility of the difference (t. p) |
|------------------------|-----------|-------------|------------------|--------------------------------------|
| nearth mulcators | 2023 2024 | | The unterence | Kenability of the difference (t, p) |
| | | Men (n=58) | | |
| BMI, kg/m ² | 24.3±0.31 | 25.6±0.45 | 1.3 | 2.38; ≤0.05 |
| RI, c. u. | 82.6±1.06 | 90.3±1.14 | 7.7 | 4.95; ≤0.001 |
| VI, ml/kg | 59.7±0.94 | 54.4±1.11 | 5.3 | 3.64; ≤0.01 |
| | | Women (n=31 |) | |
| BMI, kg/m ² | 22.6±0.37 | 23.5±0.46 | 0.9 | 1.52; >0.05 |
| RI, c. u. | 83.7±1.34 | 88.9±1.51 | 5.2 | 2.58; ≤0.05 |
| VI, ml/kg | 53.2±1.27 | 49.7±1.33 | 3.8 | 2.07; ≤0.05 |

Table 1. Comparative analysis of health indicators in law enforcement officers before and one year after graduation from the HEI SLE (M \pm m, n = 89)

Legend: M – arithmetic mean; m – error of arithmetic mean; n – number of law enforcement officers; t – t-test value; p – significance of difference between the law enforcement officers' health indicators.

Table 2. Correlation of BMI levels in law enforcement officers before and one year after graduation from the HEI SLE (n = 89, %)

| Voors of | | | BMI levels, | kg/m² | |
|----------|------------------------------|---------------------|------------------------------------|--|--|
| research | Body mass deficit (<18,5) | Norm (18,5-24,9) | Excessive body mass (25,0-29,9) | Obesity of the 1 st degree (30,0-34,9) | Obesity of the 2 nd degree (35,0-39,9) |
| | | | Men (n=58) | | |
| 2023 | 3.5 | 89.6 | 5.2 | 1.7 | - |
| 2024 | - | 53.4 | 27.5 | 13.9 | 5.2 |
| | | | Women (n=31) | | |
| 2023 | 6.5 | 87.0 | 6.5 | - | - |
| 2024 | 6.5 | 74.2 | 16.1 | 3.2 | - |

Table 3. Comparative analysis of law enforcement officers' physical fitness test scores before and one year after graduation from the HEI SLE (n = 89, %)

| Veene of veene ush | Scores for physical fitness tests | | | | | |
|--------------------|-----------------------------------|----------------------|------|----------------|--|--|
| fears of research | Excellent | Excellent Good Satis | | Unsatisfactory | | |
| | | Men (n=58) | | | | |
| 2023 | 57.8 | 21.1 | 15.8 | 5.3 | | |
| 2024 | 13.2 | 18.4 | 44.7 | 23.7 | | |
| | | Women (n=31) | | | | |
| 2023 | 80.6 | 13.0 | 6.4 | - | | |
| 2024 | 16.1 | 25.8 | 25.8 | 32.3 | | |

rated significantly. Thus, in 2024, the vast majority of law enforcement officers were rated as "satisfactory" and "unsatisfactory". The results of the tests indirectly reveal the negative impact of professional factors on the health of law enforcement officers.

DISCUSSION

In the works of scientists [2], the deterioration of the health of the male population of Ukraine in recent years in the context of social, economic, and political instability is noted: in terms of depopulation, Ukraine ranks 2nd in the world, it takes the 1st-2nd places in Europe in terms of mortality from cardiovascular diseases; the average life expectancy of men in Ukraine is 10-12 years

lower than in the European Union; more than 70 % of the adult male population has low and below-average physical health [7]. The probability of death of men in the working age is 38.4 %, which is one of the worst indicators among civilized countries of the world [8].

The analysis of scientific works by scientists [9] showed that the cumulative impact of the negative factors of modern professional activities of law enforcement officers, which mostly takes place under conditions of stress and nervous as well as emotional stress, leads to various disorders of the functions of body systems, metabolism, and overweight, which adversely affects health and causes various diseases. First of all, the cardiovascular system begins to suffer (atherosclerosis, hypertension, coronary heart disease, etc.), and the condition of the musculoskeletal system deteriorates [10]. According to scientists [11], hypertension, atherosclerosis, and obesity currently account for 60 to 80 % of fatalities in middle-aged and elderly people. In addition to cardiovascular diseases, overweight law enforcement officers may suffer from respiratory system diseases; endocrine system disorders (diabetes, hormonal disorders of the gonads); digestive system diseases (cholelithiasis, cholecystitis); deterioration of the musculoskeletal system (circulatory disorders, weakened muscles, arthritis, osteoporosis). When performing professional tasks under conditions of constant stress and nervous as well as emotional tension, law enforcement officers' psychophysiological indicators deteriorate: the distribution of attention slows down, the volume of attention and memory narrows, the speed of reaction decreases, the number of erroneous actions increases, and fatigue sets in guickly [12]. In turn, constant fatigue leads to a deterioration in health, emotional state, irritability, and aggressiveness, which accelerates the progression of professional deformation of law enforcement officers [13]. The results of our research confirmed the findings of many scientists regarding the negative impact of professional factors on the health of law enforcement officers. In addition, in our opinion, the reasons for the deterioration of law enforcement officers' health after graduation from the HEI SLE include the insufficient level of understanding by graduates of the role and importance of the principles of a healthy lifestyle and, in particular, physical activity in ensuring the effectiveness of their professional activities. According to scientists [14], a healthy lifestyle is a key element in maintaining and improving the health (physical and mental) of law enforcement officers, preventing stress, increasing the body's resistance to the negative factors of professional activities, improving the guality of performance of service tasks and prolonging professional longevity. Among the components of a healthy lifestyle, experts consider physical activity to be one of the most important components [15], which ensures an excellent level of health, high productivity of law enforcement officers, and a whole range of recreational and rehabilitation activities. Studies [16] have shown that under the influence of unfavorable factors, performance indicators of service activities decrease in law enforcement officers who systematically engage in physical activity by 10-20 %, and in those who do not – by 40-50 %. Rationally organized physical activity stimulates and regulates metabolism and the activity of important functional systems of the body, which in general has a targeted effect on improving health, maintaining body mass within the norm, increasing working capacity, and improving the effectiveness of law enforcement officers'

professional activities [17]. Scientists [18] have proven that the use of physical exercises helps to increase the activation of the synthesis of proteins and nucleic acids in the body, improve the immunobiological properties of blood and skin, and increase the body's resistance to several infectious diseases. Exercise is also an important means of preventing coronary artery disease, atherosclerosis, and its complications; improving the functioning of mechanisms that regulate vascular tone; constant activation of the circulatory system through exercise helps to strengthen the cardiovascular system and its functional capacity [19]. A trained person's cardiovascular system has more stable regulatory mechanisms than an untrained one, and sudden significant physical or mental stress in the latter can lead to a breakdown of compensatory capabilities and pathological changes in the body [20]. Scientists [21] have proven that exercise: stimulates the intestines, which reduces the time of contact of carcinogenic substances with the intestinal mucosa; reduces the risk of developing prostate disease; stimulates the immune system, especially white blood cells, which destroy cancer cells; strengthens skeletal muscles and the musculoskeletal system, preventing osteoporosis; improves the functioning of the heart and respiratory system; and helps to normalize body mass. Thus, the results of our research have shown the negative impact of professional activity factors on the health of law enforcement officers i. e. graduates of HEIs SLE. In addition, based on the work of many scientists, it can be argued that adherence to the principles of a healthy lifestyle, in particular a regimen of rationally organized motor activity, is an important area in combating the impact of negative factors of professional activities on the health of law enforcement officers.

CONCLUSIONS

It was found that the BMI of law enforcement officers for one year of service in practical units for both men and women deteriorated by 1.3 kg/m² and 0.9 kg/m², respectively. More negative changes were observed in men. At the same time, after one year of service, the number of men with overweight (27.5 %) and even obesity of the first (13.9 %) and the second (5.2 %) degrees increased significantly. In women, the changes were less pronounced: the number of overweight women increased to 16.1 %, and the number of obese women increased to 3.2 %. The dynamics of Robinson and vital indices were also negative, both for men and women: the RI significantly deteriorated in men by 7.7 c. u. ($p \le 0.001$) and in women by 5.2 c. u. ($p \le 0.05$); the VI – by 5.3 ml/kg ($p \le 0.01$) in men and by 3.8 ml/ kg (p \leq 0.05) in women.

It was also found that during one year of service, the level of physical fitness of law enforcement officers significantly deteriorated. Thus, at the end of the research, the vast majority of both men and women were rated as "satisfactory" and "unsatisfactory". The results of the research indicate a negative impact of professional factors in terms of professional activities on the health of law enforcement officers. It has been found that adherence to the principles of a healthy lifestyle, in particular, a regimen of rationally organized motor activity, is an important area in combating the impact of negative factors of professional activities on the health of law enforcement officers.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the effectiveness of stress management tools for law enforcement officers during martial law activities.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Ivan M. Okhrimenko

National Academy of Internal Affairs 1 Solomyanska Square, 03035 Kyiv, Ukraine e-mail: ivango-07@ukr.net

ORCID AND CONTRIBUTIONSHIP

Ivan M. Okhrimenko: 0000-0002-8813-5107 A B Igor V. Ozerskyi: 0000-0001-8356-0473 C Liudmyla V. Levytska: 0000-0002-2870-8663 C D Natalia H. Ivanova: 0000-0002-6108-4725 B E Yurii A. Ivanov: 0000-0003-4901-5337 D F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

Condition of oral tissues in children with congenital cleft lip and palate

Tetiana O. Timokhina^{1,2}

¹ BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE ²NATIONAL SPECIALIZED CHILDREN'S HOSPITAL "OKHMATDYT", KYIV, UKRAINE

ABSTRACT

Aim: To study the condition of oral tissues in children with congenital complete cleft lip, alveolar process, hard and soft palate.

Materials and Methods: From the examined 470 children National Specialized Children's Hospital "OKHMATDYT" (Kyiv, Ukraine) with congenital cleft lip and palate was analyzed: 302 patients aged 8-18 years were subject to in-depth analysis for clinical and radiological – 192 with unilateral and 110 with bilateral complete cleft lip, alveolar process, hard and soft palate.

Results: The average value of primary adention in patients with unilateral and bilateral complete combined cleft is 69.53%, but in females this indicator is higher and in unilateral cleft 92.18% for female against 53.17% for male. In females with unilateral cleft retention – 40.62% and overcomplete – 10,93%. The same high indicators in bilateral cleft: retention – 36.58% and overcomplete – 12.19%. Retention and overcomplete have higher values for men – 44.93% and 23.19%, respectively. Chewing efficiency in females with bilateral cleft as a result of primary dentition is below 80%. Affected by caries – 90.73% in both groups. Inflammatory processes in the periodontal tissues are revealed (80,75%): chronic catarrhal gingivitis, chronic hypertrophic gingivitis, chronic generalized periodontitis. Manifestations of atopic and angular cheilitis in 39.09% and 23.63% with bilateral cleft lip and palate, glossitis in 29.09%.

Conclusions: Patients with congenital complete cleft lip, alveolar process, hard and soft palate have high rates of adentia, retention, overcomplete dentition and a wide range of diseases of the oral cavity, which negatively affects surgical and orthodontic rehabilitation.

KEY WORDS: caries, congenital defects, cleft lip and palate, defects of the dentition, diseases of periodontal tissues, diseases of the mucous membrane of the oral cavity

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INTRODUCTION

It is known that patients born with orofacial malformations, due to unfavorable anatomical and morphological changes, tend to be more susceptible to poor oral health compared to the general population [1, 2]. Previous studies have shown that among 4-6 year old children with congenital cleft lip and palate, the prevalence of dental caries reaches 71.9%. Anterior open bite, increased oral cavity damage and periodontal disease are also more common among children with cleft lip and palate [3, 4]. At the same time, different types of congenital cleft lip and palate, according to experts, are quite different in relation to dental diseases. For example, Hazza'a et al. concluded that patients with bilateral cleft lip and palate experienced more dental caries and poor oral hygiene than patients with unilateral cleft lip and palate [5].

There are a number of hypothesized factors that may explain increased risk of caries in children with cleft lip and palate compared with their unaffected peers. According to the authors, children with cleft lip and palate are usually born in low- and moderate-resource socioeconomic areas [6, 7]. Parents typically have low oral health literacy regarding children with cleft lip and palate, also there is poor interaction with health care providers together with poor oral hygiene practices at home [8, 9]. In addition, infants with cleft lip and palate are bottle-fed longer on high-sugar formulas compared to breastfeeding [10, 11]. It was found that 55% of children with cleft lip and palate have decrease in salivation with a normal rate of salivary secretion (0.7 ml/min) [12]. Mouth breathing is common in patients with cleft lip and palate and can be considered as caries risk modifier due to a drying effect that reduces salivary production [8]. Finally, there may be a relationship between the anatomical features of the repaired cleft lip and palate, where scar tissue and uneven teeth can affect access to parts of the mouth and lead to prolonged retention of food debris [8].

Many researches have shown that oral microflora in patients with cleft lip and palate is associated with an increased frequency of potentially pathogenic fungal and bacterial colonization, particularly *Candida* species,

| Gender of the patient | Adentia of the central and lateral incisors | | | | | | entia of eeth | ary ition | teeth | mary ia | | | |
|-----------------------------|---|----------------|----------------|---------------|----------------|--------------|------------------|--------------|----------------|----------------|--------------|----------------|----------------|
| | | Pa | rtial aden | itia | | Mu | ltiple ade | ntia | | y ad | cond | et of | l pri dent |
| | | 1 tooth | 2 teeth | 3 teeth | In tota | 4 teeth | 5 teeth | 6 teeth | In tota | Primar oth | Sec defo | Fulls | Tota |
| nale | Unilateral cleft lip and palate (n=64) | 57,81% (37) | 10,93% (7) | 4,68% (3) | 73,44% (47) | 6,25% (4) | - | 1,56% (1) | 7,81% (5) | 10,93% (7) | - | 7,81% (5) | 92,19% (59) |
| Fem | Bilateral cleft lip and palate (n=41) | 17,07% (7) | 24,39% (10) | 17,07% (7) | 58,53% (24) | 9,75% (4) | 2,44% (1) | - | 12,29% (5) | 4,88% (2) | 9,76% (4) | 14,43% (6) | 75,60% (31) |
| le | Unilateral cleft lip and palate (n=128) | 33,59% (43) | 7,81% (10) | 0,78% (1) | 42,19% (54) | - | - | - | - | 10,16% (13) | 1,56% (2) | 46,09% (59) | 53,17% (67) |
| Male | Bilateral cleft lip and palate (n=69) | 21,74% (15) | 24,63% (17) | 4,34% (3) | 50,72% (35) | 5,80% (4) | 2,90% (2) | 8,69% (6) | 17,27% (12) | 8,69% (6) | 2,89% (2) | 20,28% (14) | 76,81% (53) |

Table 1. Study of the adentia frequency in children with congenital complete cleft lip, alveolar process, hard and soft palate

Staphylococcus aureus, Lactobacili and Streptococci mutans and the formation of dysbiotic biofilm microorganisms [13, 14]. It has been shown that patients with cleft lip and palate have in 2.03 times higher risk of developing caries than children without cleft lip and palate [15]. The cariogenic and periodontogenic microbiota in children and adolescents with cleft lip and palate formed by microorganisms that considered to be highly pathogenic, inducing heavy course of the disease and complications in the postoperative recovery of patients. At the same time, biofilms on the surface of the teeth produce acids that demineralize the enamel and, ultimately, allow cariogenic bacteria to invade the enamel, dentin, and even the pulp [16]. The subgingival biofilm destroys the structural integrity of the epithelium, causing inflammation, which leads to the formation of periodontal pockets [17].

Regarding periodontal microbiota, *Campylobacter spp., Fusobacterium spp., Fusobacterium nucleatum, Prevotella intermedia/nigrescens, Parvimonas micra* and *Porphyromonas gingivalis* have been highlighted in patients with cleft lip and palate [18]. *Porphyromonas gingivalis* is not common in patients under the age of 18 and its presence in children and adolescents indicates immunological changes, due to microorganism locally affects periodontal tissue, avoiding the host's protective reactions. [19]. The above data suggest to implement an intensive preventive program that should be started at an early age, which may reduce the risk of periodontal disease in the future.

Thus, the current level of knowledge indicates that children with cleft lip and palate have more risk factors for poor oral health than the general population, and are also born with a variety of dental anomalies, which



Fig. 1. a) Patient with congenital unilateral complete cleft lip, alveolar process, hard and soft palate. Multiple adentia; b) Patient with congenital bilateral complete cleft lip, alveolar process, hard and soft palate. Multiple adentia.

can not only increase susceptibility to caries, but also negatively affect periodontal condition.

Children affected by cleft lip and palate require multidisciplinary care to achieve optimal treatment results. Clinical command should prioritize oral health promotion activities to reduce the increased risk of dental disease, because early access to dental care can help to prevent the progression of dental, periodontal and oral mucosal diseases in the future.

AIM

To study the condition of oral tissues in children with congenital complete cleft lip, alveolar process, hard and soft palate.

MATERIALS AND METHODS

The dental status of 470 children with congenital cleft lip and palate was analyzed: 323 children with unilateral complete combined cleft lip, alveolar process, hard and soft palate, and 147 children with bilateral complete combined cleft lip, alveolar process, hard and soft palate. All children, according to their age, were operated on in the Department of Reconstructive and Plastic Microsurgery at National Specialized Children's Hospital "OKHMATDYT" (Kyiv, Ukraine) and undergo complex rehabilitation in the consultative and diagnostic polyclinic of National Specialized Children's Hospital "OKHMATDYT". 302 patients aged 8-18 years were subject to in-depth analysis for clinical and radiological examinations before the third stage of surgical rehabilitation (distribution by age corresponds to the stages of surgical rehabilitation): 192 with unilateral and 110 with bilateral complete cleft lip, alveolar process, hard and soft palate. Data were presented as absolute number and percentage. Data were analysed with the statistical package IBM SPSS Statistics Base (version 22).

RESULTS

From 470 patients, there were 323 (68.72%) children with congenital unilateral cleft lip and palate, 147 (31.27%) with bilateral. Gender – 109 (33.94%) female, 214 (66.23%) male. 302 (64%) patients were examined aged 8–18 years, and 192 (63.57%) from it had unilateral cleft lip and 110 (36.42%) had bilateral cleft lip. Left-sided cleft lip accounted for 202 (62.54%), of which 127 (59.35%) male and 75 (66.81%) female. Right-sided cleft lip accounted for 121 (37.46%), of which 87 (49%) male and 34 (31.19%) female.

From 323 unilateral – 60 (18.57%) from the capital of Ukraine and 263 (81.43%) from the regions of Ukraine, 203 of which patients (77.18%) with unilateral cleft lip and 60 (22.81%) with bilateral.

From 147 bilateral – 21 (14.28%) from the capital of Ukraine and 126 (85.71%) from the regions of Ukraine. From the capital – 8 female and 13 male, from the regions – 43 female and 83 male. Gender breakdown for bilateral cleft – 51 (34.69%) female, 96 (65.31%) male. From 110 patients, 23 (20.9%) came from the capital, 8 (19.51%) female and 15 (21.73%) male; 87 (79.09%) patients came from regions of Ukraine – 33 (80.48%) female and 54 (78.27%) male.

Maxillofacial deformities in the sagittal and transversal plane in congenital unilateral cleft lip and palate were found in 70.31% of children and the relative physiological norm was only 2.08%, and 73.26% in bilateral cleft lip and palate. Mainly, mesial occlusion with complications was observed in children with unilateral cleft in 34.37%, and in 34.65% with bilateral ones. Deep bite in 13.54% with unilateral cleft, and 10.89% with bilateral ones; open bite in 3.64% and in 5.94%. Crossbite observed in 35.94% and in 38.61 with bilateral cleft. A combination in two planes was found in 61.43% of all examined.

In children with congenital unilateral complete cleft lip, alveolar process, hard and soft palate only 7.8% of female patients have full set of teeth. In male patients, 1 tooth adentia – 33.59%, 2 teeth in 7.8%, 3 teeth in 0.78%, and

| | | • | | • | | |
|---|----------------------|--------------------|-----------------------|--|--|--|
| ladavaa | Unilateral cleft lip | and palate (n=192) | Bilateral cleft lip a | Bilateral cleft lip and palate (n=110) | | |
| indexes | Female (n=64) | Male (n=128) | Female (n=41) | Male (n=69) | | |
| Adentia | 92,18% (59) | 53,17 % | 75,60% (31) | 62,32% (43) | | |
| Retention | 42,18% (27) | 33,59% | 36,58% (15) | 44,93% (31) | | |
| Overcomplete teeth | 10,93% (7) | 21,13% | 12,19% (5) | 23,19% (16) | | |
| | Comb | ined pathology: | | | | |
| Adentia + retention | 26,76% (19) | 6,61% (8) | 26,83% (11) | 11,59% (8) | | |
| Full set of teeth + retention + overcomplete teeth | - | 3,30% (4) | 14,63% (6) | - | | |
| Adentia + overcomplete teeth | 2,81% (2) | 1,65% (2) | - | 2,9% (2) | | |
| Full set + retention | 1,41% (1) | 5,78% (7) | - | 7,25% (5) | | |
| Full set + overcomplete | 1,41% (1) | 0,83% (1) | - | 5,79% (4) | | |
| Adentia + retention + overcomplete | 2,81% (2) | - | - | 2,9% (2) | | |

Table 2. Development pathologies and tooth eruption in children with congenital complete cleft lip, alveolar process, hard and soft palate

Table 3. The prevalence of the oral mucosa diseases in children with congenital complete cleft lip, alveolar process, hard and soft palate

| Index | Unilateral cleft lip and palate (n=192) | Bilateral cleft lip and palate (n=110) |
|---------------------------------------|---|--|
| SD of DMFT | 5,85 | 7,97 |
| Angular cheilitis | 22,91% | 23,63% (26) |
| Glossit | 26,56% | 29,09% (32) |
| Atopic cheilitis | 36,45% | 39,09% (43) |
| Herpetic infection of the oral cavity | 7,8% | 13,63% (15) |
| Chronic recurrent aphthous stomatitis | 19,79% | 24,54% |
| Candidiasis | 7,29% | 10,0% |

other teeth were primary adentia in 10.16%. In congenital bilateral complete cleft lip, alveolar process, hard and soft palate partial adentia stated 58.53%, and multiple adentia stated 12.29% in female. Only 14.43% of female patients have full set of teeth. In male patients partial adentia stated 50.72%, and multiple adentia stated 17.27% in male. Secondary deformation – 2.89%. 20.28% of male have a full set of teeth (Table 1, Fig.1).

In case of unilateral cleft lip and palate, the masticatory efficiency in two female cases was 78% – with adentia of the central lateral incisor and second premolars. 76% – adentia of the first and two premolars and a molar. The lowest level of masticatory efficiency in male – 80% of the adentia of the central incisor and second premolars in 2 cases. With bilateral cleft lip and palate, chewing efficiency as a result of primary adentia in 9 females is below 80%, and in combination with complete retention of teeth – in 4. Thus, 34.21% of the female have chewing efficiency below 80%. In 2 female, chewing efficiency is 64% and 68% as a result of secondary deformation. 2.9% male have chewing efficiency below 80%. Chewing efficiency of 76% was observed with adentia of 12, 22, 27, 35 teeth and 60% with dentition of 15, 17, 27, 37, 46, 47 teeth.

Patients with partial or multiple primary adentia need proper preventive and therapeutic support for the preser-

vation of teeth and periodontal tissues, taking into account the chosen method of replacing teeth with incomplete dentition. The number of anomalies in the position of the teeth on the cleft side is twice as large as the number of dystopias on the opposite side. The wide variability of retained teeth location in this pathology significantly affects the plan, tactics and terms of active and retention periods of orthodontic treatment (Table 2, Fig. 2). In patients with congenital bilateral cleft lip and palate, dystopia of incisors, canines, premolars and molars is more pronounced than in patients with unilateral defects.

One of the important stages of rehabilitation for children with congenital cleft lip and palate is monitoring the condition of the hard tissues of the teeth (Fig. 3). The indicators of the prevalence and intensity of the carious process among the patients examined by us were determined as quite high. The caries situation in children with congenital bilateral cleft lip, alveolar process, hard and soft palate is significantly worse. In patients with unilateral cleft, 13.54% (26 children) had intact teeth. 551 teeth in 166 children affected by caries on the upper jaw with unilateral cleft – 3.31 teeth in one patient; 422 teeth on the lower jaw. In total, the incidence of caries is 5.85. With bilateral cleft, 502 teeth on the upper jaw and 359 teeth on the lower jaw were affected by caries. In total, the incidence of caries is 7.97. 98.18% of children



Fig. 2. Patient with congenital unilateral complete cleft lip, alveolar process, hard and soft palate.

with bilateral cleft were affected by caries – only 1.82% (2 children) had intact teeth. Complicated caries in children with bilateral cleft palate was higher than with unilateral and stated 27%.

Non-carious lesions in the form of hypoplasia were observed (24.23%), mainly systemic hypoplasia that located on teeth of the same period of formation. Enamel hypoplasia was often accompanied by a change in color, tooth sensitivity, reduced acid resistance, and erosion.

Patients with cleft lip and palate need biofilm control due to difficult access to areas for conventional hygiene techniques, reduced quality of self-cleaning, mouth breathing, tendency to retain plaque, orthodontic treatment of complex bite deformities that can last 5-7 years or more. Even in patients with a strong motivation for hygiene, long-term fixed design elements lead to high bacterial insemination, cause changes in the color of tooth enamel around braces, the formation of enamel defects, and hyperesthesia. Patients with both unilateral and bilateral cleft lip and palate complained of tooth hyperesthesia, which can also be caused by an inflammatory reaction in the pulp in reversible and irreversible pulpitis, periodontal diseases. Difficult hygiene of the oral cavity with non-unions at the same time complicates the fixation of bracket systems and orthodontic treatment in general. Even with the lowest values of the

digital data of the hygienic indices in these patients, the hygienic condition of the oral cavity was determined as unsatisfactory (72.35%), despite the constant control of the pediatric dentist, training in special care methods, and encouragement to use modern care devices.

The multifactorial nature of abnormalities of the maxillofacial system in congenital cleft lip and palate is a significant risk factor for periodontal disease. Bite anomalies increase the severity of morpho-functional disorders in the periodontium. Orthodontic treatment of patients with periodontal diseases leads to elimination of functional loads and restoration of chewing efficiency. Expanding the maxillary arch helps to change its arch shape and reduce crowding of teeth.

The condition of the periodontium in case of bilateral cleft lip and palate was much worse than in unilateral. These patients are more prone to deep periodontal destruction of the teeth adjacent to the gap. Healthy periodontium stated 20.31% with unilateral cleft and 18.18% with bilateral. These are patients with regular dental examinations and proper oral hygiene. Children with both unilateral and bilateral cleft had average severity gingivitis 55,75% Ta 57,27%. Inflammatory processes in the periodontal tissues are revealed (80,75%): chronic catarrhal gingivitis, chronic hypertrophic gingivitis and chronic generalized periodontitis.

In these children with both unilateral and bilateral cleft was revealed predisposition to inflammatory diseases of the mucous membrane of the oral cavity. Manifestations of atopic and angular cheilitis in 39.09% (43 people) and 23.63% (26 people) with bilateral cleft lip and palate, and glossitis in 29.09% (32 people) (Table 3, Fig.3). A short frenulum of the upper lip, that contributes to the development of periodontal diseases, was found in children with congenital cleft lip and palate about a third of cases (31.12%), and much lower percentage of tongue frenulum abnormality (23.17%) and pathology of the upper jaw (27.81%).

DISCUSSION

The examined contingent of patients that operated at National Specialized Children's Hospital "OKHMATDYT" with congenital complete combined cleft of the maxil-



Fig. 3. Patients with congenital bilateral complete cleft lip, alveolar process, hard and soft palate (a,b,c).

lofacial region that have extremely complex anatomical disorders and interdependent functional disorders – chewing, swallowing, breathing, speech, hearing and smell. Surgical rehabilitation restores unfused anatomical structures that must be developed to fulfill the primary functional state and facial and smile aesthetics. The interstage postoperative period requires close cooperation with otolaryngologists, speech therapists, psychologists, dentists, orthodontists and specialists to strengthen the health of children with cleft who have pronounced comorbid pathology.

Passinato Gheller et al. found that gingivitis was observed in 52% and 29%, and mild periodontitis in 48% and 22% in groups with and without cleft lip and palate, respectively [2]. Similarly, Veiga et al. found that in individuals with and without cleft lip and palate, 49% and 75% of patients had good gingival health, 22% and 24% had localized gingivitis, and 29% and 1% had generalized gingivitis. The obtained results demonstrate that the presence of cleft lip and palate is a determining factor for a higher risk of gingivitis [20].

Plakwicz et al. [21] similarly to Wyrębek et al. analyzed data of 15 patients with bilateral cleft lip and palate and found heavy bleeding and loss of clinical level of gum attachment teeth adjacent to the cleft. [22].

Gaggl et al. reported that patients with cleft lip and palate are prone to deep periodontal destruction of teeth adjacent to the cleft lip and palate. The largest number of teeth in patients with cleft lip and palate showed mobility of the I stage. According to the authors' conclusions, a critical periodontal situation was found in patients with unilateral and bilateral cleft lip and palate [23].

Assessing gingival recession as a marker of periodontal health in patients with congenital cleft lip and palate (n=200), Almeida et al. reported that the presence of recession was high, as 75% of subjects in the sample had at least one tooth with gingival recession; and 100% of persons >43 years old had at least one episode of recession, and most recessions were I class according to Miller [24]. Stec et al. reported that gingival recession was found in teeth adjacent to the cleft area [25]. Contrary to these conclussions, Wyrębek et al. did not observe gingival recession in their patients with cleft lip and palate [22].

Patients with cleft lip and palate are born with a variety of dento-maxillofacial anomalies that may not only increase susceptibility to caries, but also negatively affect the periodontal condition. Al Jamal et al. stated that the absence of teeth was found in 66.7% of patients with cleft lip and palate; the most frequently missing tooth was the lateral incisor of the upper jaw. Supernumerary teeth were found in 16.7% of patients; 37% had microdentia; 70.5% taurodontism; 30.8% – trans-

position and/or ectopic teeth; 19.2% had dilacerations; 30.8% had hypoplastic teeth. [26]. Dens invaginatus is always found in the lateral incisor of the maxilla, creating a pathological dental pocket. Such pocket destroys the periodontal tissues and allows bacteria to multiply inside, which cannot be easily removed in patients with cleft lip and palate [27].

Deformation of the upper jaw, a large number of supernumerary teeth, and incorrect placement of teeth in patients with cleft lip and palate lead to crowding of teeth and malocclusion [28].

Considering that, age is positively associated with the progression of periodontal disease, and individuals with cleft lip and palate are more likely to have plaque accumulation and gingival inflammation, clinicians should increase preventive dental care for patients from an early age [29]. In addition, in infants and children with orofacial clefts, pre- and post-operative oral inflammation pose a main risk for wound healing disorders and failure of surgery [30].

The vast majority of patients with congenital cleft lip and palate complete multi-link, timely and consistent surgical and orthodontic treatment with total positive results by adulthood.

Rehabilitation of congenital defects of the maxillofacial area consists in the anatomical and functional restoration of disturbed structures and functions performed by the orofacial apparatus: breathing, chewing, swallowing, speech, hearing and smell. Children with congenital unilateral and bilateral complete cleft lip, alveolar bud, hard and soft palate need rehabilitation to a great extent.

Restoration of impaired functions occurs before adulthood, and continues in the adult period of life. In the rehabilitation interdisciplinary doctors team, main leading role belongs to orthodont, together with the maxillofacial surgeon and the pediatric dentist to implement fully coordinated, multi-stage and multi-component treatment, the basic principles of which are professionalism, timeliness and complexity based on the continuity of polyclinic dynamic supervision with a specialized inpatient department.

The results of the examination can be used to optimize treatment and prevention actions in a complex interdisciplinary approach to the rehabilitation of children with congenital defects of the maxillofacial area; to optimize the plan of orthodontic treatment at the stages of surgical treatment, creating sufficient space on the alveolar of missing teeth by moving or replacing missing teeth: mediat-prosthesis; adhesive bridge; installation of an implant or permanent prosthetics in the future. Final corrective treatment continues into adulthood, especially in female patients.

CONCLUSIONS

- The average value of primary adention in patients with unilateral and bilateral complete combined cleft is 69.53%, but in females this indicator is higher – 16.18% (85.71% vs. 60.91%) and in unilateral cleft 92.18% for female against 53.17% for male. This indicates a functional, social and aesthetic problem and require professional, planned, consistent rehabilitation from doctors – an operating maxillofacial surgeon as a coordinator, a dentist, an orthodontist, and an orthopedist.
- Orthodontic treatment of sagittal and transverse deformities is significantly complicated by defects in the development of teeth adentia, retention 40.62% and overcomplete 10,93% in females with unilateral cleft. The same high indicators in bilateral cleft: adentia 75.61%, retention 36.58% and overcomplete 12.19%. Retention and overcomplete have higher values for men 44.93% and 23.19%, respectively.
- 3. Chewing efficiency in females with bilateral cleft as a result of primary dentition is below 80%, and in combination with complete retention of teeth is significantly reduced. Secondary deformation stated in 2.65% patients which indicates the insufficiency of timely preventive and rehabilitation work of dentists.
- 4. Affected by caries 90.73%: with congenital unilateral cleft lip and palate 86.46%, with decay-missing-filled teeth -5.85; with congenital bilateral cleft lip and palate 98.18%, with decay-missing-filled teeth -7.97. The hygienic condition of the oral cavity was determined as unsatisfactory in the majority of patients of both groups. Healthy periodontium stated 20.31% with unilateral cleft and 18.18% with bilateral. In children with both one- and two-sided cleft, with a predominance of the average severity of gingivitis 55.75% and 57.27%. Manifestations of mucous membrane diseases of the oral cavity were observed mainly cheilitis, glossitis, chronic recurrent aphthous stomatitis, herpes and candidiasis.

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Department of Dental Therapy. The topic of the research is "A multidisciplinary approach to the prevention and treatment of hard tooth tissues and periodontal diseases in person of working age" (State registration number No. 0119U104010).

CONFLICT OF INTEREST

The Author declare no conflict of interest

CORRESPONDING AUTHOR

Tetiana O. Timokhina

Bogomolets National Medical University 1 Zoologichna st., 03057 Kyiv, Ukraine e-mail: tanyatimokhina@gmail.com

ORCID AND CONTRIBUTIONSHIP

Tetiana O. Timokhina: 0000-0002-0220-0220 🔺 🖪 🕻 🗩 🗉 🗉

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔽

Epidemiology of dental caries in internally displaced children during wartime in Ukraine

Olha V. Sheshukova, Anna S. Mosiienko, Tetiana V. Polishchuk, Valentina P. Trufanova, Sofiya S. Bauman, Kateryna S. Kazakova, Vadim I. Dodatko

POLTAVA STATE MEDICAL UNIVERSITY, UKRAINE, POLTAVA

ABSTRACT

Aim: To conduct a comprehensive analysis of the oral health status of this vulnerable population in order to collect objective data that will contribute to the development of effective strategies for maintaining and improving oral health in wartime conditions.

Material and Methods: This epidemiological study was carried out within the initial 6 months of the full-scale invasion of the country. The oral health indices of 1050 internally displaced children, aged 3 to 17 years, seeking dental care at the Municipal Children Dental Clinic in Poltava, were analyzed.

Results: The total sample comprised 620 children aged 6-11 years (mean = 8.5, SD = 0.76), with a gender distribution of 52% boys and 48% girls. The participants were divided into three age groups: Group I (6-7 years), Group II (8-9 years), and Group III (10-11 years). The average prevalence of dental caries, as measured by the dmft + DMFT index, was 76.5%, with prevalence increasing with age. Specifically, the prevalence of dental caries based on the dmft index was lower in children of Group III (66.6%) compared to Group I (79.49%).

Conclusions: The analysis of the oral status among internally displaced children aged 6-11 years revealed higher dental caries prevalence and intensity compared to local children. Notably, children aged 6-7 years showed a high rate of caries in temporary teeth.

KEY WORDS: dental caries, teeth, epidemiology, oral health, internally displaced children, Wartime

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INTRODUCTION

On February 24, 2022, Ukraine endured a full-scale attack from the aggressor country, resulting in over 7 million children experiencing irreversible negative impacts on both their mental and physical health, including oral health [1, 2].

According to the statistics from the United Nations High Commissioner for Refugees (2022), the full-scale invasion of Ukraine by the Russian Federation triggered the fastest displacement crisis globally. By the end of 2022, a staggering 11.6 million Ukrainians had been forcibly displaced, with 5.9 million displaced within their own country and another 5.7 million granted refugee status, compelled to flee for their lives. Ukraine is currently grappling with its most significant crisis since the Second World War, with over 17.2 million Ukrainians in dire need of humanitarian assistance [3, 4].

Beyond the direct physical and psychological impact on the population, the consequences of war and armed conflicts extend to various difficulties, often leaving a lasting imprint on society [5, 6]. The imposition of martial law in the country results in limited access to medical care, unstable living conditions, changes in dietary habits, and restricted access to hygiene products – all of the mentioned significantly affect dental health.

One of the aspects demanding attention is the impact of war on the health of internally displaced children who have become casualties of conflicts and hostilities within their country. According to the UNICEF Executive Director, this number reached 4.3 million in Ukraine in the first month of the war, exceeding half of the country's child population [7].

Children who endure military conflicts and become internally displaced encounter specific challenges and adverse health outcomes, including an elevated risk of dental caries. As per the World Health Organization (WHO), dental caries ranks among the most prevalent global health issues. Oral health serves as an indicator for assessing overall health, consequently, dental health is acknowledged as a pivotal factor in sustaining both mental and physical well-being [8].

AIM

The aim of this study is to assess the oral health of this vulnerable group of children as the findings obtained

| Table 1. The distribution of children in the study by age and se | n the study by age and sex |
|---|----------------------------|
|---|----------------------------|

| | Age groups | | | | | | | |
|--------------------------------|---------------|---------|--------|---------|--------------|--------------|----------|------------------|
| Socio-demographic variables | Tota (N=61 | I 2) | GroupI | (n=230) | Grou (n=2 | ıp II 35) | Gr (n | oup III =147) |
| | % | n | % | n | % | n | % | n |
| Boys | 52 | 318 | 59,6 | 137 | 48,52 | 114 | 45,58 | 67 |
| Girls | 48 | 294 | 40,4 | 93 | 51,48 | 121 | 54,42 | 80 |

Table 2. Indices of dental caries intensity in the children of different age groups

| Indicas of dontal carios — | Age groups | | | | | |
|----------------------------|------------------|--------------------------|------------------------|------------------------|--|--|
| intensity | Total (n=612) | l group (n=230) | ll group (n=235) | lll group (n=147) | | |
| dmftª | 2,27±0,1 | 3,12±0,19 ^{d,e} | 2,11±0,15 ^d | 1,19±0,15° | | |
| dmft+DMFT ^₅ | 2,83±0,12 | 3,31±0,2 ^f | 2,7±0,19 | 2,27±0,22 ^f | | |
| DMFT ^c | 0,56±0,04 | 0,19±0,04 ^{g h} | 0,59±0,07 ^g | 1,08±0,13 ^h | | |

Note:

^a number of decayed, missing, and filled temporary teeth

^b average number of destroyed, missing and filled teeth

^c number of destroyed, missing and filled permanent teeth

^d p<0,005; t-Student

^e p<0,005; t-Student

^fp<0,005; t-Student

^gp<0,005; t-Student

^h p<0,005; t-Student

can be applied for elaborating programs and strategies aimed at providing dental care and preventive measures to children affected by armed conflicts and internal displacement. Moreover, the study can serve as a foundation for humanitarian interventions designed to improve the dental health of these children, thereby alleviating the potential adverse effects of martial law on both their dental well-being and overall health.

MATERIALS AND METHODS

Subjects of Study: This epidemiological investigation spanned the initial six months of the full-scale invasion (March 2022 – August 2022). The examination was carried out at the Municipal Children Dental Clinic in Poltava. This study assessed the oral health of 1050 vulnerable children, aged 3 to 17, recently internally displaced by the military conflict in Ukraine. For in-depth analysis, a targeted sample of 612 children aged 6 to 11 years was formed from the initial group. Analysis of the state of health of the oral cavity was carried out by reviewing the patient's medical history.

Data Collection: To comprehensively assess the dental health of participants, information on the following aspects was gathered for each child: sex, age, number of temporary and permanent teeth affected by dental caries, presence of malocclusion, and number of extracted teeth. Clinical examination: A standardized dental examination, adhering to the widely recognized WHO oral health assessment methodology, was conducted by a single researcher under consistent conditions to ensure accurate data collection [9]. This examination focused on two key indices: dmft (number of decayed, missing, and filled temporary teeth) and DMFT (number of decayed, missing, and filled permanent teeth). For each child, the number of teeth affected by caries was meticulously recorded and subsequently analyzed for each age group. The caries prevalence index, which represents the percentage of children having decayed teeth within each age group, was calculated. Additionally, the presence of malocclusion was documented for each participant.

STATISTICAL ANALYSIS

The collected data were entered into an Excel database. Data analysis, including both descriptive and inferential statistics, was performed using SPSS v.23. The t-Student was applied to ascertain statistically significant differences between the investigated variables.

ETHICAL CONSIDERATIONS

The official approval for collecting data and process information concerning children was granted by the



Fig. 1. Indices of dental caries prevalence in the children of different age groups.

Ethics Committee of Poltava State Medical University (No. 224). Stringent measures were implemented to guarantee the confidentiality of personal data. The entire research process adhered to the fundamental principles of ethical science, upholding the highest standards of integrity and respect.

RESULTS

According to the data obtained, the majority of children had previously resided in the Kharkiv region (56.4%) and the Donetsk region (36.1%).

The examined patients were categorized into three age groups based on socio-demographic factors: Group I (6-7 years), Group II (8-9 years), and Group III (10-11 years) (see Table 1). In the first and second groups, the number of children was nearly identical (38.4% and 37.6%), whereas the third group had a slightly lower representation (24%). Of all those examined, 52% (n=318) were boys, and 48% (n=294) were girls. The average age of the sample was 8.5±0.76 years.

The analysis of findings on dental status within the studied age groups revealed a notably high average prevalence of dental caries at 76.5% that is 468 out of 612 children had at least one decayed, filled, or missing tooth due to caries and its complications (Fig. 1).

The study indicated that the prevalence of dental caries in temporary teeth was lower in children of Group III (66.6%) compared to those in Group I (79.49%). Notably, there was a systematic increase in the prevalence of caries in permanent teeth in alignment with age: Group I – 10.43%, Group II – 27.6%, and Group III – 42.17%. The highest percentage of children with completely healthy teeth, making up a share of 31.29%, was observed in Group III, while Groups I and II showed comparable figures at 20.43% and 21.7%, respectively. 32.67% of the children included in the study had their temporary teeth extracted due to complicated caries; 48.38% of the children were diagnosed to have malocclusion.

The findings *obtained* in the medical *examination of* the children have shown that the average caries intensity slightly decreases with advancing age within the study groups (Table 2). Notably, the highest incidence has been recorded in group I, amounting to 3.31 ± 0.2 , while the lowest has been found in group III, averaging 2.27 ± 0.22 (p<0,05). The tendency in caries intensity for temporary teeth, as indicated by the dmft index, mirrors a similar pattern: group I displays the highest index at 3.12 ± 0.19 , whereas the lowest index was observed in group III at 1.19 ± 0.15 (p<0.05). In contrast, the caries intensity based on the DMFT index followed an opposite trajectory, growing with the age of the children within the groups and demonstrating a statistically significant difference (p<0.05).

No statistically significant differences were found when analyzing dental health indicators among the groups of children by gender.

DISCUSSION

This epidemiological study aimed to assess the dental health status in children internally displaced within the

country grappling with hostilities, specifically within the first six months after the commencement of a fullscale invasion. The military aggression initiated by the Russian Federation against Ukraine began in February 2014, starting with the annexation of Crimea and escalating into a full-scale invasion on 24 February 2024.

The Poltava region is among the areas in Ukraine that has accommodated a substantial number of internally displaced persons (IDPs) due to ongoing hostilities. Since the commencement of hostilities, over 200,000 IDPs have sought refuge in the region, with more than 48,000 of them being children. A notable portion of these individuals was evacuated during the initial months of the full-scale invasion, and Poltava hosted a quarter of all IDPs, who had arrived in the region [10].

The analysis of the life histories obtained from the surveyed children who took temporary shelter in Poltava, has revealed that they had been predominantly displaced from the eastern and southern territories or border areas known as active hostilities zones. The majority of the children originated from the Kharkiv and Donetsk regions.

Due to the full-scale aggression and invasion of Ukraine, there is a discernible and rapid decline in the oral health among internally displaced children that is evident not only in the prevalence rates of dental caries, but also in its intensity. These observations are supported by data from studies on the dental health of these age groups conducted prior to the onset of full-scale hostilities.

We conducted a micro-analysis of the oral health status in children aged 6-11 years, with the primary objective being a comparison of oral health indicators in these study groups with data obtained before the full-scale invasion, specifically those published on the basis of examinations of children, born and lived Poltava. According to L.F. Kaskova et al. [11] who reported about investigating caries indicators in 223 children aged 7-12 years in Poltava in 2019, the average intensity of dental caries in temporary teeth was significantly lower compared to our findings obtained in the internally displaced children, in particular, 1.45±0.14 vs. 2.27±0.1, respectively. However, the above mentioned researchers revealed a higher intensity of dental caries in permanent teeth in the local children (1.06±0.1) in comparison to our findings obtained form the internally displaced children (0.56±0.04).

Our results regarding the average caries prevalence were significantly higher in the internally displaced children aged 7 years, namely 76.46%, compared to 53.45% among children resided in Poltava. The intensity of the dental caries process, in terms of temporary teeth in children of this age who permanently resided in Poltava, was significantly lower (1.62 ± 0.25) than the findings we found in the internally displaced children (3.12 ± 0.19) . However, no significant difference was found in the intensity of dental caries in permanent teeth between 7-year-old residents of Poltava and the internally displaced children, 0.21 ± 0.05 and 0.19 ± 0.04 , respectively.

According to our data, the prevalence of dental caries in the deciduous teeth of the temporary displaced children (76.64%) exceeds the findings (51.72%) obtained from 272 children aged 6 – 11 years who resided in Poltava and its suburbs in 2020. The overall average dental caries prevalence among children aged 6 - 11 years also demonstrates a notable contrast: 61.85% in pre-war period versus 76.7% in internally displaced children. Moreover, the prevalence of caries in temporary teeth (68.14%) and permanent teeth (24.67%) of the temporary displaced children is significantly higher compared to the children in Poltava (52.59% and 19.63%, respectively). The data on the average caries intensity also indicate a decline in caries resistance among the internally displaced children, 2.83±0.12, compared to 1.5±0.12 obtained from the children in 2020 [12]. We can suggest that the higher intensity of dental caries in temporary teeth among the internally displaced children may be associated with a greater frequency of caries exacerbations due to stress and adverse living conditions.

According to Skrypnykov P.M., et al. [13] 2023, who conducted a study on the oral health of IDPs seeking dental care at the Municipal Dental Clinic in Poltava during the first 7 months of full-scale aggression, a similar pattern emerges among the adult population. Consequently, IDPs experienced 1.8 times more exacerbations of dental diseases compared to Poltava residents. The research indicates that the hygiene index was one and a half times higher in IDPs, with 100% prevalence of caries among all surveyed patients, and a majority presenting with complicated dental caries. In the group seeking dental care, the IDP subgroup was found to have a higher incidence of exacerbations in periodontal diseases. The researchers attribute these findings to the living conditions of displaced persons, who have to reside in schools, kindergartens, shelters, and the subway environments. Thus, inadequate nutrition and hygiene, coupled with the exacerbation of systemic diseases, were identified as factors adversely impacting oral health.

The dental care in the regions near the military conflict zone was already facing significant challenges prior to the full-scale aggression on 24.02.2022 caused by the wartime destruction of medical facilities, restricted access to medications and equipment, a shortage of quali-

fied dental professionals, as well as constraints in funding and logistics. An analysis of dental care in frontline cities, particularly in Donetsk Oblast where hostilities have been ongoing since 2014, reveals a substantial annual decline in the number of teeth treated for both uncomplicated and complicated caries. Examining the trend in the proportion of teeth treated for uncomplicated caries in relation to the total number of dental visits, a noticeable downward trajectory emerges. In 2018, the rate stood at 42.5%, decreasing to 41.2% in 2019, and further dropping to 36.9% and 30.9% in 2020 and 2021, respectively. This pattern is mirrored in the proportion of teeth treated for complicated caries relative to all dental visits in the population of Donetsk Oblast. The percentages ranged from 24.2% in 2018 and 25% in 2019 to 28.4% and 31.8% in 2020 and 2021 [14]. The observed dynamics suggest a decline in the accessibility and timeliness of dental care, highlighting inefficiencies within the dental care system in wartime as a whole [15].

When comparing our findings with similar studies on oral health indicators in post-conflict countries, it is noteworthy that the prevalence of dental caries in children in these regions is even higher. For instance, Bahaa A. A. et al. [16] (2018) reported an almost 90% prevalence of dental caries in Syrian children, while Rasmia Huew et al. [17] (2011) indicated a figure of about 60% in Libya. Additionally, Al-Haddad K.A. et al. [18] (2010) found that only 4% of children in Yemen were caries-free. The elevated prevalence of dental caries in children in these countries is attributed to the factors such as limited access to hygiene products, restricted opportunities for quality health care, and insufficient attention to dental health during times of crisis. These findings underscore the high relevance of thorough monitoring and improving oral health in post-conflict regions, since even in the period following the cessation of hostilities, rebuilding healthcare infrastructure and social systems is a complex process that demands time and resources. This transition period can have a significant impact on the overall health of children, including their oral health.

CONCLUSIONS

The analysis of the oral health status in internally displaced children aged 6-11 years has revealed a significant prevalence of dental caries, with an average rate of 76.47% among the participants of the study. The highest prevalence of dental caries in temporary teeth was identified in the 6-7 years age group, reaching 79.56%; the average index of dental caries intensity was 2.83, indicating a high level of caries within the study groups.

The findings obtained from this study not only create a basis for future research but also offer valuable insights for discussions and comparisons of scientific data in this field. Moreover, our study results can contribute to the development of effective strategies aimed at preserving and enhancing the dental health of internally displaced children in wartime conditions through the elaboration and implementation of proactive programs for the prevention, early detection, and treatment of caries.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Anna S. Mosiienko

Poltava State Medical University 23 Shevchenko St., 36011 Poltava, Ukraine e-mail: a.mosiienko@pdmu.edu.ua

ORCID AND CONTRIBUTIONSHIP

Olga V. Sheshukova: 0000-0002-4739-4890 A B F Anna S. Mosiienko: 0000-0003-2129-8304 A B D Tetiana V. Polishchuk: 0000-0003-1114-5830 A D Valentyna P. Trufanova: 0000-0002-7819-0188 B Sofia S. Bauman: 0000-0002-9029-8968 E Kateryna S. Kazakova: 0000-0003-2645-5778 C Vadim I. Dodatko: 0000-0002-2931-7293 E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Current state of students' health and factors as well as means of its improvement

Grygoriy P. Griban¹, Bogdan S. Semeniv², Oksana M. Alpatova³, Viktoriia B. Bakuridze-Manina⁴, Liliya M. Tomich⁵, Mykhailo O. Oliinyk⁶, Nataliia O. Khlus⁷

¹ZHYTOMYR IVAN FRANKO STATE UNIVERSITY, ZHYTOMYR, UKRAINE

²STEPAN GZHYTSKYI NATIONAL UNIVERSITY OF VETERINARY MEDICINE AND BIOTECHNOLOGIES LVIV, LVIV, UKRAINE

³ZHYTOMYR POLYTECHNIC STATE UNIVERSITY, ZHYTOMYR, UKRAINE

⁴DNIPRO STATE MEDICAL UNIVERSITY, DNIPRO, UKRAINE

⁵KYIV NATIONAL UNIVERSITY OF TECHNOLOGIES AND DESIGN, KYIV, UKRAINE

⁶BOGDAN KHMELNITSKY MELITOPOL STATE PEDAGOGICAL UNIVERSITY, ZAPORIZHZHIA, UKRAINE

⁷OLEKSANDR DOVZHENKO HLUKHIV NATIONAL PEDAGOGICAL UNIVERSITY, HLUKHIV, UKRAINE

ABSTRACT

Aim: To assess the current state of students' health in higher educational institutions in Ukraine and identify the main measures, factors, and means of its improvement.

Materials and Methods: The research was conducted in 2022-2023 and involved 266 second-year students (82 males, 184 females) from different faculties. Research methods: analysis of literary sources, observation, questionnaire surveys, and statistical methods.

Results: A general downward trend in the level of health among students in higher educational institutions in Ukraine has been established. The deterioration of the health of male students is particularly worrying: the number of students with good health has decreased by 34.1 % over the past 10 years, while the number of students with poor and very poor health has increased by 14.0 % and 3.7 %, respectively. It has been found that 41.5 % of male and 34.2 % of female students do not know the cause of their illness and do not know how to prevent it. Students are well aware of the value of their health but do not care about it, are too lazy to exercise and rely on medications or a doctor when they are ill.

Conclusions: A student's health is his or her social and personal values, level of culture, ability to withstand heavy physical and mental stress, and ability to adapt to various external factors. Therefore, the primary task of physical education departments should be to form the interests, desires, and motives of students for physical exercise.

KEY WORDS: health, health factors, physical activity, students

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INTRODUCTION

Currently, Ukraine is experiencing a steady deterioration in the health status of students in higher educational institutions (HEIs) due to low levels of physical fitness, physical inactivity, and a large number of diseases of the respiratory, digestive, eye, cardiovascular, nervous and endocrine systems, as well as various musculoskeletal disorders, infectious and parasitic diseases, etc. [1, 2]. In recent years, the health status of students has been negatively affected by the Covid-19 pandemic and martial law caused by the armed aggression of the russian federation [3, 4]. The ongoing pandemic and air alerts have forced HEIs to conduct classes remotely. The introduction of the self-isolation regime limited the motor activity of students, sports grounds and gyms stopped working, and this prompted students to perform exercises at their place of residence, which led to the development of hypokinesia [5, 6]. Hypokinesia is one of the factors in the development of various diseases, a decrease in the mental and physical working capacity of a person [7]. Therefore, the relevance of the research is due to the need to form students' motivation to take care of their health and to create a personality-oriented program of physical improvement and disease prevention through physical exercises in the present conditions.

AIM

The aim is to assess the current state of students' health in higher educational institutions in Ukraine

and identify the main measures, factors, and means of its improvement.

MATERIALS AND METHODS

The research was conducted at the Ivan Franko Zhytomyr State University in 2022-2023, involving 266 second-year students (82 males, 184 females) from different faculties.

The methodology of the scientific research on the state of students' health was carried out based on the following structural components: philosophical, general scientific, specific scientific, and technological. The research involved such general scientific methods as analysis of literary sources, which allowed to systematize scientific knowledge on the issues of students' health in HEIs (20 sources from the databases Scopus, PubMed and others were investigated); observation and questionnaire surveys, which contributed to the assessment of the real state of students' health in HEIs; statistical methods, which contributed to the qualitative interpretation of the data and the formulation of conclusions.

The health status of students in HEIs was assessed using a questionnaire survey developed by us, which contained 4 sets of questions that allowed us to establish 1) the current state of students' health; 2) measures they used to prevent their diseases, and improve their health; 3) factors that effectively influence health improvement; 4) means of motor activities used by students to improve their health during educational and independent physical training sessions.

The questionnaire survey was anonymous without any references to the authors of the article in the answers. The results were used for scientific purposes only. The questionnaire was assessed by the experts in this field (3 professors and 5 associate professors) and was approved by the Academic Council of Zhytomyr Ivan Franko State University (Protocol No. 2 dated 20.09.2022). Consent to voluntary participation in the survey was obtained from all the respondents involved in the research. This research followed the regulations of the World Medical Association Declaration of Helsinki – ethical principles for medical research involving human subjects.

RESULTS

The results of self-assessment of health by students in HEIs in 2022-2023, compared to 2012-2013, are presented in Table 1.

Self-assessment of students' health confirms the general downward trend in the level of health during

their studies in the HEI. The deterioration in the health of male students is particularly worrying; the number of students with poor and very poor health increased by 14.0 % and 3.7 %, respectively. At the same time, the number of male students in good health decreased by 34.1 %, and the number of female students decreased by 7.6 %. This situation encourages instructors to create a positive psychological environment during the educational process to distract students from everyday stressful situations, provide necessary assistance, formulate goals, and value orientations for the future, engage in a healthy lifestyle, and identify factors that positively affect their health.

At the same time, the survey of students who attended physical education training sessions showed that 41.5 % of men and 34.2 % of women could not clearly explain the nosology of their disease, its causes and preventive measures and limitations, and did not know their medical history and means of treatment. Our further research has shown that for the prevention and treatment of diseases and health promotion, students use the following measures: sleep, passive rest, purchase of medicines, active rest, visiting a family doctor, folk medicine remedies, increased motor activity, therapeutic physical education, etc. (Table 2). It is rather unfortunate that students consider the most important measures of health recovery and improvement to be not primary, namely: increased motor activity, therapeutic exercise, changes in study and life-sustaining style, and nutrition.

The value orientations of the student determine his/her motivation, purposefulness, life-sustaining activity and stance, desire to move towards mastering professional skills, and professional competencies, and, accordingly, care for his/her health and adherence to a healthy lifestyle. Among the main factors that influence the health of students are: nutrition (men – 74.4 %, women – 61.4 %); rest (50.0 % and 58.2 %, respectively); motor activity (47.6 % and 54.9 %, respectively); sleep (56.1 % and 52.7 %) (Table 3).

Among the means of motor activity that students use and want to use during educational and independent physical education training sessions, they prefer exercises on simulators (men 28.1 %, women – 28.8 %); modern fitness technologies (22.0 % and 22.3 % respectively); sports and outdoor games (19.5 % and 21.2 % respectively); table tennis and badminton (11.0 % and 18.5 %, respectively); health-improving physical culture (17.1 % and 17.9 %, respectively); swimming (9.8 % and 11.4 %, respectively); walking (8.5 % and 9.8 %, respectively) and other types (Table 4). Practical experience, observations, and conversations with students during physical education training sessions showed that mod-

| | | Instruction | The difference | |
|---------------|--------|--|---|--------|
| Health status | Gender | 2012-2013 (n = 265; male – 106; female – 159) | 2022-2023 (n = 266; male – 82; female – 184) | (%) |
| Perfect | male | 10/9.4 | 2/2.4 | - 7.3 |
| | female | 5/3.1 | 6/3.3 | + 0.2 |
| Good | male | 71/67.0 | 27/32.9 | - 34.1 |
| | female | 82/51.6 | 81/44.0 | - 7.6 |
| Satisfactory | male | 23/21.7 | 37/45.1 | + 23.4 |
| | female | 59/37.1 | 56/30.4 | - 6.7 |
| Poor | male | 2/1.9 | 13/15.9 | + 14.0 |
| | female | 12/7.6 | 32/17.4 | + 9.8 |
| Very poor | male | _ | 3/3.7 | + 3.7 |
| | female | 1/0.6 | 9/4.9 | + 4.3 |

Table 1. Comparative analysis of health self-assessment by students in HEIs of different instructional years (%)

Table 2. Use of measures for disease prevention and health promotion by students in HEIs (n = 266, %)

| Measures | Male (n = 82) | Female (n = 184) |
|---|---------------|------------------|
| Sleep | 68/82.9 | 159/86.4 |
| Passive rest | 43/52.4 | 104/56.5 |
| Visiting a pharmacy to purchase medicines | 31/37.8 | 78/42.4 |
| Active rest | 30/36.6 | 56/30.4 |
| Visiting a family doctor | 18/22.0 | 53/28.8 |
| Folk medicine remedies | 21/25.6 | 51/27.7 |
| Increasing motor activity | 19/23.2 | 47/25.5 |
| Exercise therapy training sessions | 16/19.5 | 38/20.7 |
| Changing the mode of study and life-sustaining activities | 9/11.0 | 23/12.5 |
| Making adjustments to your nutrition | 4/4.9 | 11/6.0 |
| | | |

Table 3. Assessment by students in the HEI of the most important factors of positive impact on health status (n = 266, %)

| Factors | Male (n = 82) | Female (n = 184) |
|-------------------------------------|---------------|------------------|
| Nutrition | 61/74.4 | 113/61.4 |
| Rest (active, passive) | 41/50.0 | 107/58.2 |
| Motor activity (physical education) | 39/47.6 | 101/54.9 |
| Sleep | 46/56.1 | 97/52.7 |
| Family, love | 49/59.8 | 86/46.7 |
| Prevention of diseases | 33/40.2 | 81/44.0 |
| Environment | 48/58.5 | 72/39.1 |

Table 4. Means of students' motor activity in HEIs during their academic and independent training sessions in physical education (n = 266, %)

| Types of physical activities | Male (n = 82) | Female (n = 184) |
|---------------------------------|---------------|------------------|
| Training on simulators | 23/28.1 | 53/28.8 |
| Modern fitness technologies | 18/22.0 | 41/22.3 |
| Sports and outdoor games | 16/19.5 | 39/21.2 |
| Table tennis and badminton | 9/11.0 | 34/18.5 |
| Recreational physical education | 14/17.1 | 33/17.9 |
| Swimming | 8/9.8 | 21/11.4 |
| Walking | 7/8.5 | 18/9.8 |
| Recreational running | 4/4.9 | 12/6.5 |
| Strength sports | 15/28.3 | 9/4.9 |

ern students are mostly inactive and uninterested in physical education training sessions, the main motive being to get a high grade on the test. This suggests that the modern system of physical and health-promoting education should look for new forms, means, and methods of activating and encouraging students in HEIs to exercise and take care of their health.

In general, it can be noted that the current system of physical education in HEIs is not effective enough for the development of the physical culture of students, the formation of care for their health, and the health of their loved ones and others. There is a need for a socially oriented system of scientific knowledge that would form students' high aesthetic qualities, knowledge of health, positive needs for a healthy lifestyle, and the availability of means of self-improvement and self-education.

DISCUSSION

The concept of "health" of the population is characterized by a set of indicators: demographic (birth rate, mortality, life expectancy), physical development (morphofunctional and biological development, harmony), morbidity (general, infectious), disability (primary, general), quality of donozological states (immunity, enzyme activity) [8]. Some scientists [9] consider health as a dynamic state of the highest physical and psycho-emotional well-being, which is based on a harmonious ratio of interrelated functions and structures provided by a high energy level of the body at the lowest cost of its adaptation to the conditions of life. Some experts [10] consider the main indicators of health to include: the level of immune protection and resistance, the level and harmony of physical development, the functional state of the body and its reserve capabilities, the normalcy of sexual development and sexual behavior, the presence of disease development defects, the level of moral and volitional as well as value-motivational attitudes. Among the main signs of health, the authors [11] identify the structural and functional integrity of human systems and organs, human adaptability to the physical and social environment, and preservation of the normal state of health. Scientists [12-14] distinguish the most typical definitions of the concept of "health": 1. Normal function of the body at all levels of its organization (organs, histological, cellular, and genetic structures, normal course of physiological and biochemical processes that contribute to individual survival and reproduction). Dynamic balance of the organism and its functions with the environment. 3. The ability to fully perform basic social functions, participation in social activities, and socially useful work. 4. The ability of the organism to adapt to constantly changing environmental conditions, the ability to maintain the constancy of the internal environment of the organism, ensuring normal and versatile life-sustaining activities and preservation of the living principle in the organism. 5. Absence of disease, disease states, and disease changes. 6. Full physical, spiritual, mental, and social well-being. A critical understanding of a large number of definitions of health shows that this concept is multifaceted and has different interpretations that require specificity and certainty. Therefore, we can agree with the WHO Charter, which states that health is a dynamic state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity [15].

The crisis state of the physical education system in HEIs, which does not meet state and international requirements for the health and physical fitness of students; three years of the Covid-19 pandemic, which led to self-isolation and a sharp decline in motor activity; two years of martial law, which further deepened the physical education crisis and increased psycho-emotional stress among young people in Ukraine, have created new challenges for HEIs and Ukrainian society [16, 17]. Currently, the trend of deteriorating health is progressing, and there is a decrease in the interest and motivation of students to engage in physical exercise and sports. At the same time, the state policy in the field of education is aimed at ensuring human health in all its components: spiritual, social, mental, and physical. The priority task of the education system is to teach people to take responsibility for their health and the health of others as the highest individual and social values. According to many scientists [18-20], this should be done through the development of effective valeological education, comprehensive medical care, optimization of the educational process, creation of an environmentally friendly living space, and involvement of all participants in the educational process in physical culture and sports.

CONCLUSIONS

A general downward trend in the level of health among students in higher educational institutions in Ukraine has been established. The deterioration of the health of male students is particularly worrying: the number of students with good health has decreased by 34.1 % over the past 10 years, while the number of students with poor and very poor health has increased by 14.0 % and 3.7 %, respectively. It has been found that 41.5 % of male and 34.2 % of female students do not know the cause of their illness and do not know how to prevent it. Students are well aware of the value of their health but do not care about it, are too lazy to exercise and rely on medications or a doctor when they are ill.

A student's health is his or her social and personal values, level of culture, ability to withstand heavy physical and mental stress, and ability to adapt to various external factors. Therefore, the primary task of physical education departments should be to form the interests, desires, and motives of students for physical exercise. It is necessary to identify the needs that can motivate students to engage in active and conscious physical education and health activities. Purposeful, systematic, and well-organized work to involve students in physical education and health activities can be the basis for improving their health.

Prospects for further research are aimed at studying the areas of students' involvement in HEIs in a healthy lifestyle under martial law.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Grygoriy P. Griban

Zhytomyr Ivan Franko State University 40 Velyka Berdychivska St, 10008 Zhytomyr, Ukraine e-mail: gribang@ukr.net

ORCID AND CONTRIBUTIONSHIP

Grygoriy P. Griban: 0000-0002-9049-1485 B D Bogdan S. Semeniv: 0000-0002-8302-1389 A Oksana M. Alpatova: 0000-0003-0803-9850 B Viktoriia B. Bakuridze-Manina: 0000-0002-2108-814X C Liliya M. Tomich: 0000-0002-9038-9077 D Mykhailo O. Oliinyk: 0000-0003-4131-7664 F Nataliia O. Khlus: 0000-0001-9860-1047 E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

The effectiveness of physical therapy in the rehabilitation of patients after arthroscopy of the knee joint

Valentyn V. Bondarenko¹, Iryna S. Markus², Valentyn M. Savchenko³, Svitlana I. Herashchenko², Svitlana M. Khatuntseva⁴, Inesa V. Sheremet², Natalia A. Lyakhova⁵

¹ NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE
² UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE
³BORYS HRINCHENKO KYIV METROPOLITAN UNIVERSITY, KYIV, UKRAINE
⁴BERDYANSK STATE PEDAGOGICAL UNIVERSITY, ZAPORIZHZHIA, UKRAINE
⁵POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE

ABSTRACT

Aim: To determine the effectiveness of physical therapy on the functional state of law enforcement officers' knee joints after surgical intervention.

Materials and Methods: The research involved law enforcement officers from different units of the National Police of Ukraine (n = 56) who had suffered knee joint injuries in the line of duty, and underwent surgical intervention and rehabilitation procedures.

Results: It was found that 78.2 % of respondents had suffered knee joint ligament injuries as a result of falls during rapid movement, while 43.9 % were in full gear (armored protection, helmet, etc.). It was determined that after surgical intervention, the functional state of the knee joint of law enforcement officers who followed the recommendations of physical therapy specialists and systematically performed special sets of physical exercises was significantly different (p < 0.001). Worse results were noted in people who partially followed the recommendations of rehabilitation therapists and performed part of the prescribed procedures and physical exercises.

Conclusions: The effectiveness of the complex use of physical rehabilitation means for restoring the functioning of the knee joint after surgical intervention, which included arthroscopy, partial menisectomy of the damaged areas, debridement, vaporization of damaged cartilage, etc. was revealed. The positive effect of physical exercises on the functional state of the knee joint was proven. The sets of exercises that are advisable to use to restore the functioning of the knee joint were determined.

KEY WORDS: arthroscopy, physical therapy, rehabilitation, knee joint, law enforcement officer

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INTRODUCTION

Cases of injuries to the musculoskeletal system of law enforcement officers are among the leading ones in most countries of the world [1, 2]. According to researchers, 21.4 % of such injuries are caused by damage to the menisci of the knee joint, while 17.2 % of cases of meniscus damage (often internal) are combined with a violation of the articular cartilage structure [3, 4]. This is due to the peculiarities of the anatomical structure of these joints, the tendency to post-traumatic complications, and the specifics of service tasks performance by law enforcement officers.

Experts in the field of orthopedics [5] state that the articular ligaments, muscles, and tendons of the knee joints form a complex aggregate that is easily injured when performing sudden movements from an awk-ward position, in case of overload and bruising. The

lateral and cruciate ligaments are most often damaged, as they are designed to passively hold the joints within a certain range of motion. There are also dislocations, sprains, tears, ruptures, and inflammation. Ligament damage mostly occurs during active movements, when a sudden sharp excessive movement occurs in the joint that exceeds the physiological volume (amplitude), in particular during rotation, deviation of the lower leg in the frontal plane with bending of the limb in the knee joint during a fall, walking, running, etc. [6]. Such injuries can result in joint stability disorders, which lead to reduced working capacity, and loss of proprioception, which affects the efficiency of the entire musculoskeletal system. According to researchers [7], knee joint injuries can be accompanied by pathological changes in articular cartilage, manifested in structural disorders, thinning, and delamination. In the future, this can lead

to the development of secondary gonarthrosis, a complication that can be observed in 35.5-69.7 % of cases and develops on average three to five years after injury. It has been established that in people aged 26 years and older, symptomatic gonarthrosis is observed in 5 %, in people aged 45 years and older – in 12.1 %, in people aged 60 years and older – in 11 %, in people aged 70 years and older – in 16.7 % [8].

During the war, there was a significant increase in the number of cases of traumatic injuries among law enforcement officers to various parts of the body, including knee joints. According to scientists [9], surgical intervention is a radical method of treatment for knee ligament injuries. Arthroscopy is considered the least traumatic method of recovery, which is a modern minimally invasive surgical method of visual examination of the internal structures of the joint and the contents of the joint sinus, as well as therapeutic effects on them, using thin optical and mechanical devices [10]. The restoration of knee joint function relies on a set of rehabilitation measures after surgical intervention. According to the results of studies by experts [11], the effectiveness of physical rehabilitation depends on the correct assessment of functional disorders that need to be corrected after arthroscopic surgical intervention. The researchers are convinced that the implementation of clear step-by-step physical therapy, which is considered a functional restorative therapy, will help improve treatment outcomes, including rehabilitation exercises, massage, natural and preformed factors [13]. Physical rehabilitation, depending on the nature, course, and consequences of the disease or injury, and the period and stage of the rehabilitation process, is used for prevention or treatment, or recovery. It mobilizes the body's reserve forces, activates its protective and adaptive mechanisms, increases psycho-emotional tone; prevents complications, accelerates the recovery of functions of various organs and systems and reduces the time of clinical and functional recovery; trains and hardens the body, adapts to physical activity of a domestic, educational and professional nature, restores working capacity, and improves the quality of life [13]. The systematic performance of motor actions stimulates and adapts the human body to physical activity, which gradually increases and leads to functional adaptation. The health-promoting effect of physical exercises is due to the interaction of the nervous and humoral systems as well as motor-visceral reflexes. Any muscle contraction irritates the numerous nerve endings inherent in them, and the flow of impulses is directed to the central nervous system, changing its functional state and ensuring the regulation and restructuring of the activity of internal organs through the autonomic

centers. Physical rehabilitation means, in particular the use of physical exercise sets, allow for a short period to reduce pain, increase the movement amplitude, gradually enhance the load on the damaged joint, fully or partially return to vigorous service activities, and adapt to everyday life [14].

Thus, the analysis of the literary sources showed that a significant number of publications have been devoted to the study of the effect and effectiveness of physical therapy for the restoration of the functional state of the knee joint after injury and surgical intervention, while the effectiveness of physical rehabilitation and, in particular, exercise sets after arthroscopy of the knee joint in modern conditions is not sufficiently disclosed, which determined the relevance of our research.

AIM

The aim is to determine the effectiveness of physical therapy on the functional state of law enforcement officers' knee joints after surgical intervention.

MATERIALS AND METHODS

The research involved the use of several theoretical and empirical methods, including analysis, synthesis, classification, generalization, guestionnaire surveys, observation, and methods of mathematical statistics. The research was conducted in 2022-2024. Determining the effectiveness of physical therapy during the rehabilitation of law enforcement officers after knee arthroscopy involved the conduct of the questionnaire survey. The survey was carried out in three stages. Stage 1 – one month after the surgical intervention; stage 2 – 2 months, stage 3 – 5 months after the surgical intervention. The survey involved law enforcement officers from various structural units of the National Police of Ukraine (n = 56) who had sustained knee injuries in the line of duty and underwent surgical intervention and rehabilitation. The grounds for surgical intervention were based on the appropriate diagnosis. In particular, the law enforcement officers had persistent pain in the knee joint, degenerative changes and damage to the posterior horn of the medial meniscus, chondral damage and ulceration of the cartilage of the lateral condyle of the femur, subtotal tear of the anterior cruciate ligament, chondromolysis of the knee joint, etc. The surgical intervention included: arthroscopy of the knee joint, partial menisectomy of the damaged areas, debridement, vaporization of the damaged cartilage segments, synovial membrane, chondral damage, and osteoperforation.

The questionnaire survey included several questions

related to anthropometric data (weight, height), age, conditions of injury, the list of physical therapy tools used during the rehabilitation procedure, and questions from the KOOS (Knee injury and Osteoarthritis Outcome Score) questionnaire [15]. The KOOS questionnaire is designed to study the subjective assessment of the functional status of the injured knee joint using a special rating scale. The scale contains five subsections, including:

- symptoms 7 points (swelling of the knee joint, feeling of friction, crunching, pinching, stiffness, bending amplitude, etc.);
- pain 9 points (frequency of pain; degree of pain in different positions and the course of various movements in the knee joint);
- daily activities 17 items (moving up and down stairs, bending and extending the knee joint from different positions, changing positions, different types of walking, and performing various household tasks aimed at self-care, etc.);
- sports and recreational function 5 items (questions related to the peculiarities of performing active motor activities: squats, running, jumping, twisting, etc.);
- quality of life 4 items (frequency of discomfort, degree of difficulty in everyday life due to the knee joint problem).

All items have five possible answers, ranging from 0 (no problems) to 4 (extreme problems), and each of the five scores is calculated as the sum of the selected items. Scores from 0 to 100 are a percentage of the total possible score. The total score is not calculated, as the selected aspects are analyzed and interpreted separately. The scores on the scales were calculated using the following formulas:

Symptoms = $100 - (average score on the scale (S1-S7) \times 100/4)$

Pain = 100 – (average score on the scale (P1-P9) \times 100/4)

Daily activities = $100 - (average score on the scale (A1-A17) \times 100/4)$

Sports and recreational function = $100 - (average score on the scale (SR1-SR5) \times 100/4)$

Quality of life = $100 - (average score on the scale (Q1-Q4) \times 100/4)$

The determination of physical exercise sets that had a positive effect on the restoration of knee joint function during rehabilitation under restrictions caused by the introduction of martial law was based on the analysis of the results of the questionnaire survey.

Statistical analysis was applied to correctly process the data and identify the difference between the indicators under study. The significance of the difference in the results was determined during the studying based on the Student's t-test. The significance for all statistical tests was set at p<0.05. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all participants who took part in this research.

RESULTS

The results of the questionnaire survey revealed that 78.2 % of respondents suffered knee ligament injuries as a result of falls during rapid movement, while 43.9 % were wearing equipment (armored protection, weapons, helmet, etc.), 34.3 % of employees experienced pain and swelling after prolonged movement and staying in an upright position. 21.8 % of people said that the surgical intervention was prompted by an exacerbation of a long-standing injury. It was found that among the respondents there were 13 people under the age of 25; 19 people – 26-30 years; 13 people aged 31-35 years; 8 – 36-40 years; and 3 people – 41-45 years. The average age of the operated employees was 29.9 ± 0.80 years, the average weight was 83.4 ± 1.43 kg.

The analysis of issues related to the attitude of law enforcement officers to physical therapy, compliance with the recommendations of rehabilitation specialists, and the list of physical exercises used to restore knee joint functioning gave grounds to distinguish three groups of people. In particular, group 1 (n = 9) included law enforcement officers who, despite the difficulties caused by martial law, followed the recommendations of physical therapy specialists and attended most of the prescribed procedures (physiotherapy, massage, hydromassage) and systematically performed special sets of physical exercises throughout all stages of rehabilitation. Individuals in group 2 (n = 32) partially followed the recommendations of rehabilitation therapists, participated in some of the prescribed procedures and exercises at the first stage of rehabilitation; not systematically at the second stage of rehabilitation, and did not use physical exercises to restore knee joint function at the third stage of rehabilitation. Individuals in group 3 (n = 15) did not follow the recommendations of physical therapy specialists and did not engage in procedures and exercises to restore knee joint function more quickly at any stage of rehabilitation.

A thorough study of the questions provided by the KOOS questionnaire showed significantly better (p < 0.001) results of subjective assessment of the functional state of the knee joint in group 1 (Table 1). This was true for all three stages of the questionnaire survey. In particular, stage 1 revealed the most significant difference in the manifestation of postoperative symptoms (knee joint swelling, feeling of friction, crunching, pinching, stiffness, bending amplitude, etc.), which were estimated at 32.2 ± 0.52

| Indicators | Group 1 | Group 2 | Group 3 (n = 15) | Reliability of the difference | | | | | |
|--|-----------|-----------|---------------------|-------------------------------|----------------------------|-----------------------------|--|--|--|
| | (n = 9) | (n = 32) | | р1–р2 | р2–р3 | р1–р3 | | | |
| Stage 1 (1 month after the surgical intervention) | | | | | | | | | |
| Symptoms | 32.2±0.52 | 21.3±0.45 | 19.7±0.53 | <i>p</i> <0 . 001 | <i>p</i> <0 . 05 | <i>p</i> <0 . 001 | | | |
| Pain | 38.9±0.35 | 33.3±0.39 | 32.2±0.49 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Daily activities | 48.6±0.82 | 44.1±0.37 | 43.5±0.26 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Sports and recreational function | 30.1±0.55 | 22.5±0.38 | 16.5±0.28 | <i>p</i> <0 . 001 | <i>p</i> <0 . 001 | <i>p</i> <0 . 001 | | | |
| Quality of life | 31.2±0.66 | 18.8±0.30 | 17.7±0.48 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Stage 2 (2 months after the surgical intervention) | | | | | | | | | |
| Symptoms | 67.8±0.71 | 57.1±0.52 | 55.6±0.96 | <i>p<</i> 0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Pain | 69.4±0.60 | 61.1±0.41 | 59.4±0.65 | <i>p</i> <0 . 001 | <i>p</i> <0 . 05 | <i>p</i> <0 . 001 | | | |
| Daily activities | 75.0±0.65 | 72.1±0.30 | 69.1±0.22 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Sports and recreational function | 52.5±0.74 | 32.5±0.71 | 29.9±0.42 | <i>p</i> <0 . 001 | <i>p</i> <0 . 01 | <i>p</i> <0 . 001 | | | |
| Quality of life | 62.5±0.67 | 40.5±0.62 | 39.6±0.48 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Stage 3 (5 months after the surgical intervention) | | | | | | | | | |
| Symptoms | 92.8±0.48 | 85.7±0.76 | 82.1±0.86 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Pain | 98.2±0.43 | 86.4±0.45 | 85.7±0.75 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Daily activities | 98.2±0.33 | 88.3±0.59 | 87.5±0.30 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |
| Sports and recreational function | 96.4±0.38 | 80.2±0.59 | 78.5±0.30 | <i>p</i> <0 . 001 | <i>p<</i> 0 . 05 | <i>p<</i> 0 . 001 | | | |
| Quality of life | 98.9±0.21 | 85.7±0.77 | 85.1±0.39 | <i>p</i> <0 . 001 | <i>p</i> >0 . 05 | <i>p</i> <0 . 001 | | | |

Table 1. Results of the questionnaire survey of law enforcement officers (n = 56) who underwent knee surgical intervention, points (according to the KOOS scale)

p1-p2, p2-p3, p1-p3 – significance of the difference between the indicators of law enforcement officers of groups 1, 2, 3 using the Student's t-test.

points (p < 0.001). The employees of groups 2 and 3 were characterized by 21.3 ± 0.45 and 19.7 ± 0.53 points, respectively (p < 0.05). The results of the assessment of the effectiveness of sports and recreational functions (squats, running, jumping, twisting, etc.) differed significantly in all three groups. In law enforcement officers of group 1, this indicator was 30.1 ± 0.55 points (p < 0.001), in group 2 – 22.5 \pm 0.38 points, and 16.5 \pm 0.28 points in group 3 (p < 0.001). The results show that the systematic and comprehensive use of the recommended means of physical therapy has a more pronounced effect on reducing the manifestations of symptoms after surgical intervention, promoting more effective restoration of knee joint mobility. This has a positive effect on the indicators of daily activities and quality of life. In particular, the items of the KOOS questionnaire, which determined the frequency of discomfort, the degree of difficulty in everyday life, etc. were significantly better (p < 0.001) in law enforcement officers of group $1 - 31.2 \pm 0.66$ points, which is 12.4 points higher than in group 2 (18.8 \pm 0.30) and 13.5 points higher than in group 3 (17.7 ± 0.48). There was no significant difference in the quality of life indicators among the employees in groups 2 and 3 (p > 0.05). The

representatives of group 1 showed less pain (p < 0.001) and higher rates of daily activities (p < 0.001) during all three stages.

The analysis of the results of the questionnaire survey at stage 2 showed the effectiveness of physical therapy means, in particular dosed exercise sets, to restore the functioning of the knee joint. There was a more than 10 points difference between group 1 and individuals of other groups in the items that determine the quality of life, symptoms, sports, and recreational function (p < 0.001). Among law enforcement officers of groups 2 and 3, a significant difference was found in the items of the KOOS scale characterizing the feeling of pain (p < 0.05) and sports and recreational function (p < 0.01).

At stage 3, the representatives of group 1 scored more than 90 points on all items of the KOOS scale, which was significantly higher (p < 0.001) than in groups 2 and 3. In particular, the indicators of group 1, which determine pain, daily activities, and quality of life, are close to the level that characterizes the absence of any problems – 98.2 ± 0.43, 98.2 ± 0.33, and 98.9 ± 0.21 points, respectively. Among the persons of groups 2 and 3 the studied indicators differed significantly only in the item concerning sports and recreational function (p < 0.05). These results demonstrate the effectiveness of physical exercise sets for the restoration of knee joint function after surgical intervention.

Based on the analysis of the questionnaire surveys, physical exercise sets that contribute to more effective restoration of knee joint function were determined. During the first stage of rehabilitation, isometric exercises to strengthen the quadriceps femoris and hamstrings were effective. In the second stage – isotonic exercises without load. During the third stage of recovery – strength exercises with moderate load. The selection and dosage of physical exercises depends on the complexity of the injuries sustained before the surgical intervention, the presence of concomitant diseases, the age of the person, individual characteristics, including the level of physical fitness, the degree of soft tissue damage, etc.

DISCUSSION

Scientists state that significant subjective factors that lead to injuries to law enforcement officers are neglect of personal safety measures, fatigue, and lack of attention [2, 16]. To ensure full recovery from musculoskeletal injuries, physical therapy exercises, combinations of various physiotherapy procedures, and massages are used. These means accelerate the reduction of acute manifestations of pain and help accelerate adaptation processes. Experts [17] state that therapeutic exercises for meniscectomy are prescribed on the second day after surgical intervention. This is due to the need to improve blood circulation in the area of surgical intervention, normalize knee joint trophism, gradually eliminate joint mobility restrictions, stimulate the contractility of the thigh muscles, and improve overall working capacity. During the first stage of rehabilitation, in particular the first four days after the surgical intervention, the patient should perform general strengthening and special exercises in the starting position lying on the back, then sitting and standing. Given that the movements in the knee joint improve blood and lymph circulation, as well as the secretion of synovial fluid, relax muscles, relieve pain, and affect tissue regeneration, healing, and complete restoration of morphological structures [18].

According to scientists, the second stage of rehabilitation (from 3-4 weeks to 2-2.5 months after surgical intervention) is aimed at eliminating postoperative synovitis with residual knee joint contracture and severe muscle hypotrophy. The objectives of rehabilitation during this period are the complete removal of contractures in the knee joint, restoration of normal gait and adaptation to prolonged walking, training of strength endurance of the thigh muscles, and restoration of general working capacity [19]. The third stage of recovery, which lasts from 2-2.5 to 4-5 months after surgical intervention, is aimed at adaptation to slow running, and restoration of thigh muscle strength. The signs of clinical and functional recovery are the performance of several motor tests, including: squatting with full amplitude; walking in a full crouch; squatting on the operated leg (75 % of the number of squats on a healthy leg); not excessive running for 30 minutes. The data obtained confirm the findings of scientists [20] regarding the positive effect of exercise on the restoration of knee joint function after surgical intervention. Thanks to the use of a specially selected set of exercises, the connections between muscles and nerve endings are restored faster and the lost mobility is restored. This is due to the therapeutic effect of the main mechanisms of physical exercises: toning, trophic, compensation, and normalization of functions.

CONCLUSIONS

Based on the research, the causes and characteristics of law enforcement officers' injuries that led to the need for surgical intervention were identified. It was been found that the largest number of law enforcement officers who underwent knee arthroscopy were aged 26-30 years, with the average age of the operated officers being 29.9 ± 0.80 years.

It was found that after surgical intervention, the functional state of the knee joint of law enforcement officers who attended most of the prescribed procedures (physiotherapy, massage, hydromassage) and systematically performed special sets of physical exercises during all periods of rehabilitation was significantly better (p < 0.001) for all items of the KOOS scale (symptoms; pain; daily activities; sports and recreational function; quality of life). Worse results were observed in people who partially followed the recommendations of rehabilitation therapists, and performed part of the prescribed procedures and physical exercises at the first stage of rehabilitation and not systematically at the second stage.

It has been stated that isometric exercises to strengthen the quadriceps femoris and hamstrings at the first stage of rehabilitation; isotonic exercises without load at the second stage; and strength exercises with moderate load at the third stage of recovery have a positive effect on the faster recovery of the knee joint after surgical intervention, which included arthroscopy, partial menisectomy, debridement, vaporization of damaged cartilage segments.

PROSPECTS FOR FURTHER RESEARCH

We plan to study the effect of hydrotherapy and massage on the restoration of knee joint performance at the second stage of rehabilitation.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Natalia A. Lyakhova

Poltava State Medical University 24 Shevchenko st., 36000 Poltava, Ukraine. e-mail: natanew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP

Valentyn V. Bondarenko: 0000-0002-0170-2616 Iryna S. Markus: 0000-0003-0071-9798 Valentyn M. Savchenko: 0000-0002-8483-9748 Svitlana I. Herashchenko: 0000-0002-7829-9722 Svitlana M. Khatuntseva: 0000-0001-9123-6366 Inesa V. Sheremet: 0000-0001-8766-8115 Natalia A. Lyakhova: 0000-0003-0503-9935 F

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CONTENTS 🔼

Dynamics of components of physical and mental health of law enforcement officers during the period of martial law

Olena O. Yevdokimova, Vadym B. Kharchenko, Iryna V. Zhdanova, Oksana P. Liaska, Olena P. Makarova, Olena M. Mokhorieva, Yuliia V. Sarbiei

KHARKIV NATIONAL UNIVERSITY OF INTERNAL AFFAIRS, KHARKIV, UKRAINE

ABSTRACT

Aim: To investigate the dynamics of law enforcement officers' physical and mental health components while performing their duties during the war in Ukraine. **Materials and Methods:** The research, which was conducted in 2022-2024, involved 114 law enforcement officers (male) from the Kharkiv oblast (Ukraine) of different ages: under 30 (n = 35), under 40 (n = 41), over 40 (n = 38). To test law enforcement officers' physical and mental health indicators, we used 3 methods: 1) "Fatigue-Monotony-Oversaturation-Stress"; 2) "Well-being-Activity-Mood"; 3) "Assessment of Nervous and Emotional Stress"

Results: The negative dynamics of most components of the physical and mental health of law enforcement officers of all three groups while performing their duties during the martial law were revealed. The most pronounced significant changes occurred in such components as "Fatigue", "Oversaturation", "Stress", "Well-being", "Mood", "Nervous and Emotional Stress". The most pronounced negative changes in most components occurred in law enforcement officers over 40 years old, which is due to both the age characteristics of the subjects and their length of service.

Conclusions: The research confirms the high complexity and extremity of law enforcement officers' service activities during the martial law, as well as the high requirements for law enforcement officers' readiness to perform tasks in the context of a significant expansion of the National Police's powers. The results obtained also necessitate the search for effective ways to preserve and maintain the physical and mental health of law enforcement officers.

KEY WORDS: physical health, mental health, law enforcement officers, police, martial law, war

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INTRODUCTION

The National Police of Ukraine is a state law enforcement agency, which is designed to protect human rights and freedoms, combat crime and maintain public order and public safety. The tasks of the National Police are: ensuring public safety and public order; protecting and defending human rights and freedoms, as well as the interests of society and the state; combating crime; providing, within the limits established by law, assistance services to persons who, for personal, economic, social reasons or as a result of emergencies, need such assistance [1]. With the introduction of martial law in Ukraine on February 24, 2022, the powers of the National Police were expanded to strengthen necessary and legitimate security measures [2]. Thus, the legal regime of martial law provides for the following additional law enforcement measures: enhanced protection of public order and security; combating sabotage and reconnaissance forces; protection of strategically important facilities and vital communications; ensuring the interaction of territorial defense entities; facilitating the activities of the military administration, courts, prosecutors, judicial authorities during the period of martial law; escorting persons detained on suspicion of committing a criminal offense, taken into custody, accused or sentenced to imprisonment, as well as guarding them in the courtroom; apprehending in detention centers of persons arrested for committing criminal or administrative offenses, persons subject to detention as a preventive measure, persons subject to administrative arrest, as well as accused and convicted persons; operational demining: detection, neutralization and destruction of explosive devices; technical and forensic support for the inspection of the scene, including those related to fires, and special explosive works in the event of explosions, reports of suspicious explosive devices, threats of explosion, activities during curfew and service at checkpoints, in conditions where active hostilities are taking place (as part of the process of de-occupation of territories); evacuation of Ukrainian citizens from dangerous areas, sending humanitarian aid to areas where active hostilities are taking place, etc. [3, 4]. In addition, police officers were given the right to use coercive measures against persons involved in armed aggression against Ukraine without taking into account the established requirements and prohibitions on the use of physical force, weapons, etc. [1, 5]. All of the above indicates that the introduction of the martial law regime has significantly increased the requirements for the quality of law enforcement and, accordingly, for the professional psychophysical readiness of law enforcement officers to perform their duties in a toughened environment. According to many scientists [6, 7], the intense activities of law enforcement officers during martial law, as well as several negative factors that accompany it, lead to a deterioration in both the physical and mental health components of law enforcement officers. This is reflected in the functioning of the cardiovascular, respiratory, endocrine, digestive, and nervous systems of law enforcement officers; many show signs of mental disorders (aggression, irritability, increased anxiety, emotional exhaustion, deterioration of relationships with colleagues, family, and others), a decrease in mental and physical working capacity, and, as a result, a decline in the effectiveness of professional and service tasks [8, 9]. Therefore, the research on the dynamics of law enforcement officers' physical and mental health components while performing their duties during the war in Ukraine is relevant to substantiate further directions for ensuring and maintaining both the physical and mental health of law enforcement officers, as well as preventing the negative impact of factors of service activities during the legal regime of martial law.

AIM

The aim is to investigate the dynamics of law enforcement officers' physical and mental health components while performing their duties during the war in Ukraine.

MATERIALS AND METHODS

The research was conducted at the Department of Sociology and Psychology of Kharkiv National University of Internal Affairs (Kharkiv, Ukraine) in 2022-2024. The research involved 114 law enforcement officers (men) of different ages who performed their service duties in the Kharkiv oblast during the legal regime of martial law: under 30 years old (group a, n = 35), under 40 years old (group b, n = 41), over 40 years old (group c, n = 38). The study of law enforcement officers' physical and mental health indicators was conducted in two stages (during the advanced training courses at Kharkiv National University of Internal Affairs): the first stage – April-May 2022, and the second – April-May 2024. During the war, all law enforcement officers performed their duties in practical units of the National Police.

To achieve the purpose of the research, we used the following methods: theoretical (analysis, synthesis, and generalization), empirical (pedagogical observation, testing of physical and mental health indicators), and statistical (sampling method). To test law enforcement officers' physical and mental health indicators, we used 3 methods: 1) "Fatigue-Monotony-Oversatura-tion-Stress"; 2) "Well-being-Activity-Mood"; 3) "Assessment of Nervous and Emotional Stress" [10, 11].

The Fatigue-Monotony-Oversaturation-Stress method is an adapted version of the German BMS II questionnaire and is designed to assess the severity of the four components of the current functional state of law enforcement officers that are manifested during their service activities. The method contains 40 statements that need to be evaluated on a 4-point scale: rarely – 1 point, sometimes – 2 points, often – 3 points, almost always – 4 points. The results are processed by calculating four coefficients (fatigue coefficient (Fc), monotony coefficient (Mc), oversaturation coefficient (Oc), and stress coefficient (Sc)). If the value of any coefficient is 18 points or less, the component under study is not expressed; 19-29 points – moderately expressed; 30 points and more – strongly expressed.

The method referred to as "Well-being-Activity-Mood" is designed to quickly assess such functional states of law enforcement officers as well-being, activity, and mood. The respondent had to correlate his or her state with several signs on a multi-stage scale. The scale consists of indices (3 2 1 0 1 2 3) and is arranged between thirty pairs of words (ten for each state) of opposite meanings, which reflect mobility, speed, and pace of functions (activity), strength, health, fatigue (well-being), and characteristics of the emotional state (mood). When processing the data, the respondents' scores were recorded as follows: index 3, which corresponds to poor health, low activity, and low mood, is taken as 1 point; the next index 2 is taken as 2 points; index 1 is taken as 3 points, and so on until index 3 on the opposite side of the scale, which is taken as 7 points. For each functional state, arithmetic averages were calculated and evaluated as follows: if the average score was from 1 to 3 points, the law enforcement officer's state was considered low; 4, 5 – average; 6, 7 – high.

The method referred to as "Assessment of Nervous and Emotional Stress" contains signs of nervous and emotional stress based on clinical observations and includes 30 characteristics of this state, divided into three degrees of severity (a – low degree (complete absence), b – average degree, c – high degree). The

| Components | Groups (p) | Years of study | | • | 4 m |
|----------------|------------|----------------|-----------|-----|--------------|
| | Groups (n) | 2022 | 2024 | Δ | t; p |
| Fatigue | a (n=35) | 23.7±0.38 | 25.4±0.41 | 1.7 | 3.04; ≤0.01 |
| | b (n=41) | 27.2±0.33 | 29.4±0.36 | 2.2 | 4.50; ≤0.001 |
| | c (n=38) | 28.8±0.35 | 31.2±0.37 | 2.4 | 4.71; ≤0.001 |
| Monotony | a (n=35) | 17.3±0.27 | 17.7±0.29 | 0.4 | 1.01; ≥0.05 |
| | b (n=41) | 16.8±0.26 | 17.4±0.27 | 0.6 | 1.60; ≥0.05 |
| | c (n=38) | 17.5±0.30 | 17.8±0.29 | 0.3 | 0.72; ≥0.05 |
| Oversaturation | a (n=35) | 22.3±0.32 | 25.7±0.35 | 3.4 | 7.17; ≤0.001 |
| | b (n=41) | 21.8±0.29 | 25.3±0.31 | 3.5 | 8.24; ≤0.001 |
| | c (n=38) | 23.2±0.31 | 27.1±0.34 | 3.9 | 8.48; ≤0.001 |
| Stress | a (n=35) | 31.2±0.40 | 34.1±0.41 | 2.9 | 5.06; ≤0.001 |
| | b (n=41) | 30.6±0.35 | 32.9±0.37 | 2.3 | 4.52; ≤0.001 |
| | c (n=38) | 31.3±0.37 | 33.2±0.39 | 1.9 | 3.53; ≤0.001 |

Table 1. Results of assessing law enforcement officers' physical and mental health components using the "Fatigue-Monotony-Oversaturation-Stress" method (n = 114, in points)

Note: n – the number of law enforcement officers; Δ – the difference between the indicators for 2022 and 2024; t – the value of the Student's t-test; p – the confidence interval.

characteristics include physical discomfort; pain; muscle tone; coordination of movements; amount of motor activity; self-assessment of the cardiovascular system; gastrointestinal tract; respiratory system; sweating and skin rashes; sleep patterns; state of the will; peculiarities of mental processes (memory, attention, thinking); intellectual working capacity; mental discomfort, etc. By choosing one of the three options (a, b, c), law enforcement officers assessed their current state. The data is processed by summing the scores: for answers a – 1 point, b – 2 points, c – 3 points. The range from 30 to 50 points characterizes a low level of nervous and emotional stress, 51-70 points – average; from 71 to 90 points – high.

The significance of the difference between the studied indicators of law enforcement officers was determined by means of Student's t-test. The statistical significance was set at p<0.05. All statistical analyses were performed with the SPSS software, adapted to medical and biological researches. This research was carried out in accordance with the requirements of the Regulations on Academic Integrity of the Kharkiv National University of Internal Affairs. This research also followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all law enforcement officers who took part in this research.

RESULTS

The dynamics of law enforcement officers' physical and mental health components according to the "Fa-

tigue-Monotony-Oversaturation-Stress" method are presented in Table 1.

Fatigue is a functional state of the body caused by intense or prolonged activity, accompanied by a decrease in working capacity and deterioration in the guality of activity. Thus, according to the component referred to as "Fatigue", law enforcement officers of all three groups showed a significant deterioration of indicators by 1.7-2.4 points, which confirms the increase in the complexity of service activities during the legal regime of martial law. The greatest changes in the "Fatigue" component can be seen in law enforcement officers over 40 years old. At the same time, in all three groups in 2022 and groups a and b in 2024, this component is moderately pronounced, and in group c in 2024 it is highly pronounced, which can be explained by the age characteristics of the subjects. Monotony is a functional state of the body that occurs as a result of monotonous activity and is accompanied by a decrease in tone, and control, deterioration of memory, and attention, and decreased interest in work. According to the "Monotony" component, the indicators of the subjects of all three groups have not changed significantly during the war and are not pronounced at all stages of the research, which is explained by the diversity of tasks of law enforcement officers of practical police units during the war. Oversaturation is a condition that results from intense and complex activities, which can also lead to the search for ways to change activities. The "Oversaturation" component shows a significant deterioration in the indicators of law enforcement officers of all three groups by 3.4-3.9 points, which suggests the complexity and extremity of law enforcement activities in the legal
| Components | Groups (n) | Years o | of study | Δ. | 6 1 m | |
|------------|------------|----------|----------|-----|--------------|--|
| Components | Groups (n) | 2022 | 2024 | - Δ | ι; p | |
| | a (n=35) | 6.5±0.17 | 5.6±0.18 | 0.9 | 3.64; ≤0.001 | |
| Well-being | b (n=41) | 6.2±0.14 | 5.1±0.16 | 1.1 | 5.17; ≤0.001 | |
| | c (n=38) | 5.8±0.16 | 4.3±0.17 | 1.5 | 6.43; ≤0.001 | |
| | a (n=35) | 6.7±0.18 | 5.9±0.19 | 0.8 | 3.06; ≤0.01 | |
| Activity | b (n=41) | 6.5±0.15 | 5.6±0.16 | 0.9 | 4.10; ≤0.001 | |
| | c (n=38) | 6.1±0.17 | 4.9±0.18 | 1.2 | 4.85; ≤0.001 | |
| Mood | a (n=35) | 4.2±0.14 | 3.3±0.15 | 0.9 | 4.39; ≤0.001 | |
| | b (n=41) | 4.6±0.13 | 3.5±0.14 | 1.1 | 5.76; ≤0.001 | |
| | c (n=38) | 4.1±0.15 | 2.9±0.16 | 1.2 | 5.48; ≤0.001 | |

| Table 2. | Results of | assessing | law enfor | rcement o | officers' p | physical | and men | al health: | component | s using the | "Well-being | -Activity-Mood | d" method |
|-----------|------------|-----------|-----------|-----------|-------------|----------|---------|------------|-----------|-------------|-------------|----------------|-----------|
| (n = 114, | in points) | | | | | | | | | | | | |

Note: n – the number of law enforcement officers; Δ – the difference between the indicators for 2022 and 2024; t – the value of the Student's t-test; p – the confidence interval.

Table 3. Results of assessing law enforcement officers' physical and mental health components using the "Assessment of Nervous and Emotional Stress" method (n = 114, in points)

| Components | Groups (p) | Years of | of study | | t; p | |
|------------------------------|-------------|-----------|-----------|------|--------------|--|
| components | Groups (II) | 2022 | 2024 | Δ | | |
| Nervous and Emotional Stress | a (n=35) | 53.7±1.81 | 64.2±1.87 | 10.5 | 4.03; ≤0.001 | |
| | b (n=41) | 51.9±1.57 | 61.8±1.65 | 9.9 | 4.35; ≤0.001 | |
| | c (n=38) | 52.4±1.63 | 60.9±1.71 | 8.5 | 3.60; ≤0.001 | |

Note: n – the number of law enforcement officers; Δ – the difference between the indicators for 2022 and 2024; t – the value of the Student's t-test; p – the confidence interval.

regime of martial law. At the same time, the oversaturation indicators correspond to a moderate level of severity in all three groups, both in 2022 and 2024. Stress is a functional state of the body that occurs as a result of the negative impact of activity factors on mental functions, nervous processes, and the activity of its organs and systems. In the "Stress" component, all groups of respondents showed a significant deterioration in their scores by 1.9-2.9 points. Moreover, in both 2022 and 2024, the level of stress was highly pronounced in all groups, and no significant difference was found between the scores of respondents of different ages, which confirms our previous conclusions about the complexity of the conditions of service of law enforcement officers of different ages during the war.

The study of the components of physical and mental health of law enforcement officers using the "Well-being-Activity-Mood" method allows us to conclude that all three states in all age groups of law enforcement officers have significantly deteriorated over the two years of war (Table 2). Thus, according to the "Well-being" component, which was assessed by such characteristics as a sense of strength, working capacity, health, freshness, fatigue level, endurance, cheerfulness, etc., the indicators of the group a employees deteriorated by 0.9 points, group b – by 1.1 points, group c – by 1.5 points. It was found that in 2022, the "Well-being" of law enforcement officers of groups a and b corresponded to a high level, and of group c - to an average level, while in 2024, all groups recorded an average level.

The component referred to as "Activity" is characterized by such features as mobility, activity, speed, enthusiasm, excitement, attentiveness, etc. Thus, the value of deterioration in this component is 0.8 points in group a, 0.9 points in group b, and 1.2 points in group c. The level of the "Activity" component in all groups deteriorated from high to average. In the "Mood" component, which is characterized by happiness, cheerfulness, optimism, calmness, hope, and satisfaction, the scores significantly deteriorated in all groups by 0.9-1.2 points. At the same time, the level of this component dropped from average in 2022 to low in 2024. It has been found that the most pronounced negative changes in the "Well-being", "Activity", and "Mood" components occurred in law enforcement officers of group c (aged 40 and older). This is due to age-related changes in the body of law enforcement officers, the length of law enforcement activity, which leaves an imprint on their health, and the body's reaction to the negative factors of service activities under the legal regime of martial law.

The study of the dynamics of law enforcement offi-

cers' physical and mental health components using the "Assessment of Nervous and Emotional Stress" method shows that over the two years of war, in all three groups of subjects, there was a significant deterioration in indicators characterizing nervous and emotional stress (self-assessment of cardiovascular, respiratory, digestive and excretory systems, quality of sleep; the state of the emotional and volitional sphere; peculiarities of cognitive processes, etc.) by 10.5 points in group a, by 9.9 points in group b and by 8.5 points in group c (Table 3).

It should be added that in both 2022 and 2024, the nervous and emotional stress of law enforcement officers of all three groups corresponds to the average level. At the same time, the most pronounced changes were found in law enforcement officers under the age of 30, which may be due to their lack of emotional maturity and the large volume of tasks in practical police units during the war in Ukraine.

DISCUSSION

Martial law is a special legal regime introduced throughout the country or in certain areas in the event of armed aggression or threat of attack, imminence to the state independence of Ukraine, and its territorial integrity and provides for the granting of powers to the relevant state authorities, military command, military administrations and local self-government bodies necessary to avert the threat, repel armed aggression and ensure national security, eliminate the threat to the state independence of Ukraine, its territorial integrity as well as temporary restrictions of constitutional rights and freedoms of a person and citizen and the rights and legitimate interests of legal entities caused by the threat, indicating the duration of these restrictions [12, 13]. Under the decision of the National Security and Defense Council of Ukraine, enacted in accordance with the established procedure by a decree of the President of Ukraine, military formations formed following the laws of Ukraine are involved together with law enforcement agencies in solving tasks related to the introduction and implementation of measures of the martial law regime, following their purpose and specifics of activity [2].

According to scientists [5, 14], the National Police officers focus their activities on the internal threat of martial law in Ukraine, especially social criminalization, the development of the "shadow economy", various manifestations of terrorism, inadequate law and order, and low security. Therefore, the main function of law enforcement agencies in ensuring martial law is to respond to threats, which is achieved by addressing issues such as fighting crime, and terrorism in all its forms, ensuring public safety, etc. Scientists also [2, 12,

13] identify the following priority areas of activity of police bodies during the legal regime of martial law: recording and qualification of war crimes in Ukraine; investigation of war crimes in conditions of active hostilities; demining of territories and buildings; protection of public order and ensuring public safety; detection of cases of unlawful acts against children; use of modern information technologies, systems and means of information protection; psychological support of the activities of police bodies in conditions of martial law and provision of primary psychological assistance by police officers to various categories of citizens. All of this eloquently demonstrates the complexity and extreme nature of law enforcement officers' service activities during the legal regime of martial law, which is accompanied by high risk to the lives of law enforcement officers, stress, and high nervous as well as emotional stress, and with prolonged exposure can lead to deterioration of physical and mental health and the emergence of several diseases [15-17]. The results of our research complement and extend the findings of many scientists [18, 19], who argue about the negative impact of law enforcement officers' service activities on the components of their physical and mental health. Among the practical recommendations of experts on the prevention of negative changes in the physical and mental health of law enforcement officers we find [20-22]: regulation (if possible) of work and rest (sleep) regimes; balanced nutrition; constant motor activity (regular exercise of varying intensity depending on the age and health status of law enforcement officers); application of mental self-regulation methods (autogenous training, breathing exercises, meditation, self-massage, work with biologically active points, exercises to relieve tension, etc.); giving up bad habits. All of these areas require further research.

CONCLUSIONS

The negative dynamics of most components of the physical and mental health of law enforcement officers of all three groups while performing their duties during the legal regime of martial law were revealed. The most pronounced significant changes occurred in such components as "Fatigue" (by 1.7-2.4 points), "Oversaturation" (by 3.4-3.9 points), "Stress" (by 1.9-2.9 points), "Well-being" (by 0.9-1.5 points), "Mood" (by 0.9-1.2 points), "Nervous and Emotional Stress" (by 8.5-10.5 points). The most pronounced negative changes in most components occurred in law enforcement officers over 40 years old, which is due to both the age characteristics of the subjects and their length of service.

The research confirms the high complexity and extremity of law enforcement officers' service activities during the legal regime of martial law, as well as the high requirements for law enforcement officers' readiness to perform tasks in the context of a significant expansion of the National Police's powers. The results obtained also necessitate the search for effective ways to preserve and maintain the physical and mental health of law enforcement officers, as well as to prevent the negative impact of law enforcement factors during wartime.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the dynamics of physical and mental health indicators in female law enforcement officers during the martial law.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Olena O. Yevdokimova

Kharkiv National University of Internal Affairs 27 Lva Landau Avenue, 61000 Kharkiv, Ukraine e-mail: elena25eva@gmail.com

ORCID AND CONTRIBUTIONSHIP

Olena O. Yevdokimova: 0000-0003-4211-7277 A F Vadym B. Kharchenko: 0000-0002-2412-7909 A B Iryna V. Zhdanova: 0000-0002-6361-3029 B E Oksana P. Liaska: 0000-0001-6943-8957 B D Olena P. Makarova: 0000-0002-5480-5942 C D Olena M. Mokhorieva: 0000-0002-9420-2847 D F Yuliia V. Sarbiei: 0009-0004-0837-7221 C F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Applied value of modern fitness technologies in improving the health and physical development of students

Andrii A. Rebryna¹, Yevhen V. Bazhenkov², Anatolii A. Rebryna³, Halyna A. Kolomoiets², Tetiana K. Bondar⁴, Tetiana A. Malechko²

¹NATIONAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS OF UKRAINE, KYIV, UKRAINE ²STATE SCIENTIFIC INSTITUTION "INSTITUTE FOR MODERNIZATION OF THE CONTENT OF EDUCATION", KYIV, UKRAINE ³KHMELNYTSKYI NATIONAL UNIVERSITY, KHMELNYTSKYI, UKRAINE ⁴UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE

ABSTRACT

Aim: To study the impact of modern fitness technologies on the health and physical development of students in the learning process. **Materials and Methods:** The research involved 108 students (52 male and 56 female students), which formed the experimental (EG) and the control (CG) groups. The EG male students were engaged in such type of fitness technologies as Strenflex during physical education training sessions, and the EG female students – Dance Aerobics. Students' health was assessed by Stange and Genchi tests, Rufier and strength indices; and physical development – by the level of development of physical qualities.

Results: It was found that Strenflex training sessions have a positive effect on all studied health indicators of male students (Stangea and Genchi tests, Rufie and strength indices), and Dance Aerobics training sessions are more effective in improving the functional capabilities of the respiratory and cardiovascular systems, and less effective in developing the strength capabilities of female students. It has also been established that the most pronounced effect of the applied modern fitness technologies is on the development of strength qualities in men, endurance, and flexibility in men and women.

Conclusions: The effectiveness of modern fitness technologies in physical education in educational institutions to improve students' health and physical development has been proven. The level of health and physical development of students, formed in the process of conscious training, will contribute to their successful learning and life-sustaining activities, as well as to maintaining the necessary level of motor activity in the future.

KEY WORDS: health, physical development, fitness technologies, physical education, students

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INTRODUCTION

The health of the nation is a significant indicator of the social and economic development of every developed country [1]. Unfortunately, the majority of Ukrainians today cannot boast of good health, nor can they boast of a long life. In Ukraine, the average life expectancy for men is 66 years, and for women it is 74-76 years [2]. Recently, there has been a rapid deterioration in the physical and mental health of the population of Ukraine, including student youth, due to the full-scale invasion of the russian aggressor and the introduction of martial law, the coronavirus pandemic, shortcomings in the health care system, the social and economic crisis, a sharp decline in the standard of living and quality of life against the backdrop of a poor environmental and political situation in the country, etc. [3, 4]. Among the main reasons for the deterioration of the health of modern youth, scientists also see the lack of effectiveness of the modern organization of physical education in higher educational institutions (HEIs) of Ukraine [5, 6]. Scientists point out that students are uninterested in attending traditional physical education training sessions [7, 8]. The main reasons for the low motivation of students to take physical education training sessions in HEIs are the lack of choice of the form of training sessions and dissatisfaction with the traditional content of physical education training sessions. In addition, most traditional means and methods of physical education cannot be used at home during distance learning, as well as in the future to maintain health and the required amount of motor activity during independent study [9].

Foreign experience [10, 11] shows that in many countries of the world, significant importance is given to club forms of physical education organization, which are implemented through the use of modern health-improving fitness technologies that contribute to the optimization of students' motor activity and allow for variability and, at the same time, high efficiency of the process of physical education of student youth. According to experts [12], fitness technologies are, first of all, technologies that ensure effectiveness in fitness training sessions. More precisely, they can be defined as a set of methods, and techniques, formed into a certain algorithm of actions, which is implemented in the interests of improving the efficiency of the health process, providing a guaranteed result based on a free motivated choice of physical exercises using innovative means, methods, organizational forms, as well as modern inventory and equipment [13].

Modern fitness technologies are created in the fitness industry, which is developing rapidly and takes all the most valuable things that have been developed over many years in health-improving physical culture to solve its problems [14]. Fitness technologies have recently gained considerable popularity and occupy a strong position in the modern socio-cultural demand – the need of society for healthy and physically developed people. Their number and focus are very difficult to classify, they are constantly updated and improved. In general, scientists [13, 15, 16] identify several main groups of modern fitness technologies: cardio training (Step Aerobics, Cycle, Slide Aerobics, Bosu Training, Kangoo Jumps, Functional Training and others), strength training (Crossfit Training, Strenflex, Tabata Training, Body Sculpt, Street Workout, Barbell Workout, Bodybar Workout and others), dance training (Dance Aerobics, Zumba Fitness, Hip-hop, Street Dance, Modern Dance, Belly Dance, Pole Dance and others), training with elements of martial arts (Tai-bo, Aikido, Kickboxing, Body Combat and others), training in the water environment (Aqua Fitness, Aqua Gym, Aqua Jogging, Aqua Stretching and others), and training of psycho-regulatory orientation (Pilates, Stretching, Yoga and others). Such a variety of fitness technologies is determined by the desire to satisfy different physical culture, sports, and health interests of the general population [14]. At the same time, the rational and purposeful introduction of fitness technologies into the system of physical education in HEIs for health improvement, development, and education of student youth is today one of the main and urgent tasks of modernization of the content of education in HEIs.

AIM

The aim is to study the impact of modern fitness technologies on the health and physical development of students in the learning process.

MATERIALS AND METHODS

This research was conducted during 2021-2023 at the Department of Theory and Methods of Physical Edu-

cation and Sport of Khmelnytskyi National University (Ukraine). The research involved 108 students (52 male and 56 female students), which formed the experimental (EG) and the control (CG) groups. The EG male students (n = 26) were engaged in such type of fitness technologies as Strenflex during physical education training sessions, and the EG female students (n = 28)- Dance Aerobics. The training sessions were conducted by professional fitness trainers who are members of the Department of Theory and Methods of Physical Education and Sport. The CG students (men (n = 26) and women (n = 28)) were engaged in traditional methods of physical education under the guidance of the department's teachers. Students were divided into groups at the beginning of the academic year by free conscious choice of students after the introductory briefing. The students were informed about the availability of specialists at the HEI and the conditions for training in modern health and fitness technologies. The number of hours spent on physical education for the EG and the CG students during the study was the same. The duration of the experiment was 2 years, during the 1st and 2nd year of study.

Strenflex (strength aerobics) is a system of multi-vector exercises based on the implementation of three main areas of fitness: strength, endurance, and flexibility. That is, training with this type of fitness technology is aimed at developing strength, aerobic capacity, and flexibility. The goal of Strenflex is to train the whole body, reflecting a modern lifestyle focused on ensuring a good appearance, and healthy lifestyle, slowing down the aging process, and maintaining creative, physical, and mental performance. Strenflex training involves various types of training sessions: ABS (abdominal, back, spine) - strength combined movements aimed at working out the muscles of the back and abs; ABT (abdominal, bums, thighs) - strength combined movements aimed at working out the muscles of the back and legs; TABS (total abdominals) - strength combined movements aimed at working out the muscles of the back, abs, and muscle corset; Upper Body - strength combined movements aimed at working out the muscles of the arms, shoulders, chest, upper back and abdominal muscles; Low Body - strength combined movements aimed at working out the muscles of the legs, back, and abs; Body Sculpt - strength combined movements aimed at working out the muscles of the whole body; and other combined movements with and without equipment [17].

Dance Aerobics training sessions are based on a harmonious combination of dosed exercises for general development, running, jumping, and dance elements, organized by emotional rhythmic music, and performed without pauses for rest (in a streaming manner). Dance aerobics is based on various dance styles. Each type of dance aerobics is characterized by movements and music corresponding to a particular style of dance. The training was conducted in a medium or high-intensity mode [18].

Research methods: analysis and generalization of literary sources, medical and biological methods, testing, statistical analysis. The method of analysis and generalization of literary sources contributed to the study of the literature on the topic of the research (25 sources from the databases PubMed, Scopus, Web of Sciences, Index Copernicus and others were investigated). Medical and biological methods were used to study health indicators of students. We determined the following indicators: timed inspiratory (Stange test) and expiratory (Genchi test) capacity – to assess the respiratory system; the Rufier index - to assess the cardiovascular system; and the Strength index – to assess the development of the students' muscular system. Testing was used to assess the physical development of students based on the results of the following tests: 100 m run (speed qualities), pull-ups (for male students) and push-ups (for female students) (strength qualities), 1 km run (endurance), and leaning torso forward (flexibility).

Statistical analysis was applied to correctly process the data and identify the difference between the indicators under study. The compliance of the data distribution with the Gauss' law was assessed using the Shapiro-Wilk W-test. The significance of the difference in the results of the students was determined during the studying based on the Student's t-test. The significance for all statistical tests was set at p < .05. All statistical analyses were performed with the SPSS software, version 10.0. This research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects and was approved by the Academic Council of Khmelnytskyi National University (Protocol No. 2 dated 03.09.2021). Informed consent was received from all students who took part in this research.

RESULTS

Assessment of students' health indicators at the beginning of the research shows that for all studied indicators there was no significant difference between the EG and the CG, both in men and women (p > 0.05). Instead, at the end of the research, a significant advantage was found in the respiratory and cardiovascular system functional capabilities indicators in the EG students, both men and women (Table 1). Thus, in the tests with breath-holding in the EG students at

the end of the research significantly better indicators were recorded compared to the CG, by 6.5 s in the Stange test (p < 0.05) and by 4.6 s in the Genchi test (p < 0.01). The EG women also showed significantly better respiratory holding capacity than the CG ones, by 9.4 s in the Stange test (p < 0.01) and by 3.25 s in the Genchi test (p < 0.05). The level of functional state of the respiratory system in the EG students (males, females) at the end of the research was assessed as "excellent", and in the CG - as "good". The Rufier index of male and female students of the EG at the end of the research was also significantly better than in the CG, by 0.33 c. u. and 0.43 c. u., respectively. At the same time, the functional state of the cardiovascular system of the EG and the CG students corresponded to a sufficient level. According to the results of the research on the strength index, a significant difference between the EG and the CG indicators was found only in men - it was 4.11 % (p < 0.01). It was also found that during the 1^{st} and 2nd years of study at the HEI, all indicators of the EG, unlike the CG, significantly improved (p < 0.05; p < 0.001). The analysis shows that Strenflex training sessions have a positive effect on all studied health indicators of male students, and Dance Aerobics training sessions are more effective in improving the functional capabilities of the respiratory and cardiovascular systems, and less effective in developing the strength capabilities of female students.

Analyzing the physical development of students, we found that there was no significant difference between all indicators of the EG and the CG (p > 0.05) at the beginning of the research. At the end of the research, certain dependencies were revealed: fitness technologies have the most pronounced effect on the development of strength qualities in men, endurance, and flexibility in men and women, but are not effective enough in the development of speed qualities. Thus, at the end of the research, there was no significant difference between the results of the 100 m run in the EG and the CG neither in male nor in female students (p > 0.05) (Table 2).

Significantly better results in pull-ups in male students of the EG compared to the CG were found at the end of the research: the difference was 2.8 times (p < 0.001). No significant difference was revealed in push-ups (p > 0.05) in the EG and the CG women. According to the results of the 1 km run and torso tilting forward, the positive influence of both types of fitness technologies on the development of endurance and flexibility of the EG students was established. At the end of the research, the difference in the results of the 1 km run was 15.5 s in men and 14.9 s in women (p < 0.001); in torso tilting – 4.5 cm in men and 4 cm

| Health indicators | Gender | Research stages | EG | CG | t | р |
|---------------------|--------|-----------------|---------------|--------------|------|-------|
| | | Beginning | 55.7±1.95 | 56.2±2.03 | 0.18 | >0.05 |
| Chan and hand a | IVI | End | 66.1±1.84** | 59.6±1.97 | 2.41 | <0.05 |
| Stange test, s | | Beginning | 51.6±1.89 | 50.9±1.92 | 0.26 | >0.05 |
| | F | End | 63.5±1.81*** | 54.1±1.85 | 3.63 | <0.01 |
| | | Beginning | 35.6±0.88 | 34.8±0.92 | 0.63 | >0.05 |
| Conshitest s | IVI | End | 43.1±0.82*** | 38.5±0.87* | 3.85 | <0.01 |
| Genchi test, s | | Beginning | 32.9±0.95 | 33.2±1.04 | 0.21 | >0.05 |
| | F | End | 40.7±0.89*** | 37.2±0.96** | 3.85 | <0.05 |
| | N.4 | Beginning | 7.39±0.09 | 7.21±0.10 | 1.34 | >0.05 |
| Dufer index a u | IVI | End | 5.86±0.08*** | 6.19±0.09*** | 2.74 | <0.05 |
| Ruffer Index, c. u. | | Beginning | 7.11±0.10 | 7.15±0.10 | 0.28 | >0.05 |
| | F | End | 6.05±0.09*** | 6.48±0.10*** | 3.20 | <0.01 |
| | | Beginning | 58.41±0.99 | 57.95±0.96 | 0.33 | >0.05 |
| Strongth index 0/ | IVI | End | 64.18±0.91*** | 60.07±0.93 | 3.16 | <0.01 |
| Strength Index, % | F – | Beginning | 39.60±0.85 | 38.81±0.90 | 0.64 | >0.05 |
| | | End | 41.33±0.79 | 40.24±0.91 | 0.90 | >0.05 |

| Table 1. Dynamics of health indicators of the EG and the CG st | udents during their 1st and 2nd instructional years ($X \pm m$, $n=108$) |
|--|---|
|--|---|

Note: M – male students; F – female students; X – arithmetic mean; m – error of arithmetic mean; t – Student's test value; p – reliability value; * - p < 0.05; ** - p < 0.01; *** - p < 0.001.

| Table 2. Dy | ynamics of p | hysical develo | pment indicators o | f the EG and the | CG students during their | r 1st and 2nd instructional | years ($X \pm m$, $n = 108$) |
|-------------|---|----------------|--------------------|------------------|--------------------------|-----------------------------|---------------------------------|
| | , | / | | | <u> </u> | | |

| Physical development indicators | Gender | Research stages | EG | CG | t | р |
|------------------------------------|--------|-----------------|---------------|--------------|------|--------|
| | | Beginning | 14.5±0.12 | 14.4±0.13 | 0.57 | >0.05 |
| 100 | IVI | End | 14.1±0.11* | 14.2±0.12 | 0.61 | >0.05 |
| 100 m run, s | | Beginning | 16.8±0.11 | 16.9±0.12 | 0.61 | >0.05 |
| | Г | End | 16.6±0.10 | 16.7±0.11 | 0.67 | >0.05 |
| Dull une times | 5.4 | Beginning | 9.8±0.47 | 9.5±0.43 | 0.47 | >0.05 |
| Pull-ups, times | M | End | 15.1±0.41*** | 12.3±0.46* | 4.54 | <0.001 |
| Duch une times | F | Beginning | 12.2±0.54 | 11.9±0.49 | 0.41 | >0.05 |
| Push-ups, times | | End | 15.4±0.58** | 13.9±0.55* | 1.88 | >0.05 |
| | | Beginning | 265.2±2.16 | 259.8±2.23 | 1.74 | >0.05 |
| 1 // | M | End | 231.7±1.97*** | 247.2±2.09** | 5.40 | <0.001 |
| i km run, s | | Beginning | 306.5±2.29 | 309.9±2.41 | 1.02 | >0.05 |
| | г | End | 276.8±2.06*** | 291.7±2.30** | 4.83 | <0.001 |
| | 5.4 | Beginning | 7.9±1.11 | 8.1±1.16 | 0.12 | >0.05 |
| Looping torso forward | IVI | End | 13.5±1.15** | 9.0±1.14 | 2.78 | <0.05 |
| Leaning torso forward, cm | | Beginning | 11.6±0.97 | 12.1±1.02 | 0.36 | >0.05 |
| | F | End | 17.5±1.06*** | 13.5±1.05 | 2.68 | <0.05 |

Note: M – male students; F – female students; X – arithmetic mean; m – error of arithmetic mean; t – Student's test value; p – reliability value; * - p < 0.05; ** - p < 0.01; *** - p < 0.001.

in women (p < 0.05). The conducted research proved a more vivid positive effect of consciously chosen training sessions with modern fitness technologies, compared to the traditional method of physical education in HEIs, on strengthening health and improving the physical development of student youth.

DISCUSSION

According to scientists [19], today the higher education system of Ukraine is at the stage of fundamental changes, characterized by a new understanding of the goals and objectives of education and the need to modernize many academic subject areas, including physical education, with new modern methods and techniques of effective educational and health improvement activities of students using fitness technologies, to create quality higher education and form a healthy young generation. According to scientists [20], in recent years in Ukraine, attention to the popularization of a healthy lifestyle among the population, including students, has increased significantly. This is evidenced by the state leadership's awareness of the problems of preventing non-communicable diseases, which puts the preservation of public health on par with the preservation of the country's sovereignty, welfare, and other national interests of the state.

Indeed, according to many scientists [21], improving the health status of modern high schoolers and students is the main task in pedagogical science, because health is the second in the hierarchy of needs, inferior to human life. Health is considered by some scientists as a state of well-being and well-doing of the body, as the ability to counteract the negative impact of the environment, and as the highest vital value of a person and society [22]. According to other authors [23], health is the degree of ability of an individual or group, on the one hand, to realize their aspirations and meet their needs, and on the other hand, to change the environment or cooperate with it. Scientists interpret the process of forming and strengthening the health of young people while studying in educational institutions as the creation of an optimal psychosomatic constitution within the framework of a possible genotype and the prevention of possible diseases. The main principles and means of forming the health of student youth embrace ensuring optimal living conditions (study, everyday life), which include the absence of stress, rational nutrition, adequate sleep; absence of bad habits; optimal motor activity, and systematic physical activity [24]. It is difficult to overestimate the role of physical exercises on the health of students, however, today, in the process of physical education of students at HEIs, it is necessary to use such means that students would be engaged consciously, motivated, and with interest [25]. That is why most experts advise introducing modern fitness technologies into the system of physical education to massively and consciously involve students in active recreational exercise while studying at a HEI, taking into account the capabilities of the educational and sports base of the HEI and the availability of specialists in a particular type of fitness technology [26].

A wide range of modern fitness technologies will not only update the content of physical education at HEls, motivate students to exercise, and lead a healthy lifestyle, but also relieve additional financial burden on educational institutions, as most technologies do not require inventory and equipment. By actively using a variety of physical exercises from modern fitness technologies, students improve their health, physical development, and fitness [14, 15, 18]. The results obtained in our research confirm the conclusions of many scientists and prove the effectiveness of the use of modern fitness technologies in the physical education at HEls to improve the health and physical development of students.

CONCLUSIONS

The conducted research proved a more vivid positive effect of consciously chosen training sessions with modern fitness technologies, compared to the traditional method of physical education at HEIs, on improving the health and physical development of students. It was found that Strenflex training sessions have a positive effect on all studied health indicators of male students (Stangea and Genchi tests, Rufie and strength indices), and Dance Aerobics training sessions are more effective in improving the functional capabilities of the respiratory and cardiovascular systems, and less effective in developing the strength capabilities of female students. It has also been established that the most pronounced effect of the applied modern fitness technologies is on the development of strength qualities in men, endurance, and flexibility in men and women, but is not effective enough in the development of speed qualities.

The effectiveness of modern fitness technologies in physical education in educational institutions to improve students' health and physical development has been proven. The level of health and physical development of students, formed in the process of conscious training, will contribute to their successful learning and life-sustaining activities, as well as to maintaining the necessary level of motor activity in the future.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the effectiveness of other types of modern fitness technologies in improving students' health.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Tetiana A. Malechko

Institute for Modernization of the Content of Education 36 Metropolitan Vasyl Lipkovsky st, 03035 Kyiv, Ukraine e-mail: tanya.bubley@ukr.net

ORCID AND CONTRIBUTIONSHIP

Andrii A. Rebryna: 0000-0002-5108-2793 A Yevhen V. Bazhenkov: 0000-0003-0117-294X D Anatolii A. Rebryna: 0000-0001-7707-5324 B Halyna A. Kolomoiets: 0000-0002-4315-3977 B C Tetiana K. Bondar: 0000-0001-5953-6713 E Tetiana A. Malechko: 0000-0001-9430-6745 D F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

The use of botulinum toxin type a to prepare patients with large ventral hernias for laparoscopic hernioplasty: Our experience

Tetiana V. Tarasiuk¹, Oleksandr Yu. loffe¹, Oleksandr M. Chukanov², Mykola S. Kryvopustov¹, Oleksandr P. Stetsenko¹

¹ BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE ² LIFESCAN-CLINIC, KYIV, UKRAINE

ABSTRACT

Aim: To study the effectiveness of BTA in a total dose of 100 IU as the preparation for patients with primary and incisional ventral hernias (VH).

Materials and Methods: The prospective study included 59 patients with large VH (defect ³10 cm). All patients received 100 IU of BTA in abdominal wall muscles 4-5 weeks before surgery from June 2017 to December 2022. An average age of the patients was 59.13 ± 9.07 years, body mass index $- 32.20 \pm 4.95$ kg/m². **Results:** An average width of the hernia defect after BTA decreased by 4.5 ± 1.11 cm (p<0.001). An average length of the hernia defect after BTA also decreased, without clinical significance. A significant increase in the length of the abdominal wall and a decrease in its thickness were observed. The abdominal cavity volume after BTA increased by $4.04 \pm 4.55\%$ (p=0.008) and the hernial sac volume decreased by $21.43 \pm 16.57\%$ (p=0.005). All patients underwent surgery with hernia defect suturing and without component separation: laparoscopic IPOM hernioplasty - 50 (84.7%) patients, open IPOM hernia repair - 7 (11.9%) patients, open sublay hernioplasty - 2 (3.4%) patients. There was no recurrence of hernia during 12 months after surgery.

Conclusions: The administration of 100 IU BTA allows to increase the length of the abdominal wall muscles and to perform laparoscopic IPOM hernioplasty for patients with large VH.

KEY WORDS: botulinum toxin, ventral hernia, hernia repair, laparoscopic hernioplasty

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INTRODUCTION

Operations for VH are one of the most common in surgery [1, 2]. Surgical methods of treatment of VH vary depending on the size of the hernia defect, its localization, and the concomitant pathology of the patient [3, 4]. The use of mesh to strengthen the anterior abdominal wall is the basical approach of VH surgical repair in elective surgery [5-12].

Laparoscopic methods of treatment can be used for VH diameter up to 15 cm [11]. But when the width of the hernial defect is up to 10 cm, laparoscopic methods are recommended. At the same time, the suturing of the hernia defect when using the laparoscopic method of hernioplasty is recommended by the guidelines [11] and remains at the discretion of the surgeon [8]. When VH repair is performed using the intraperitoneal onlay mesh technique (IPOM), suturing of the hernia defect demonstrates a reduction in the risk of seroma formation and hernia recurrence [11].

Currently, there is a tendency to decrease the number of laparoscopic IPOM hernioplasty in the treatment

of incisional VH [13]. One of the explanations for this tendency can be the increased number of incisional VH with the size of the hernia defect greater than 10 cm during 2010-2019 yy. and limited recommendations for the use of laparoscopic methods of hernioplasty for large hernias. For hernias larger than 10 cm the hernia defect suturing is technically difficult without using the component separation technique and may require the use of additional preparation methods in the preoperative period [11].

In 2009, Ibarra-Hurtado et al. published the proposition to use botulinum toxin type A (BTA) in the preoperative period for relaxation of the muscles of the anterior abdominal wall in patients with VH [14]. Since the publication of this work, the use of BTA in the treatment of large VH has not become a common practice and requires further study of the effectiveness and standardization of the technique [12, 15]. In the updated guideline of International Endohernia Society (IEHS) about laparoscopic treatment of ventral and incisional hernias (2019) there is no recommendations for the use of BTA in prepara-

| Fable 1. Demographic and Pre-operative Data | | | | | |
|---|----------------------------|--|--|--|--|
| Characteristic | N | | | | |
| Total number of patients: | 59 (100%) | | | | |
| women | 37 (62.7%) | | | | |
| men | 22 (37.3%) | | | | |
| Average age, years | 59.13 ± 9.07 | | | | |
| Body mass index, kg/m ² | 32.20 ± 4.95 | | | | |
| ASA score: I | 8 (13.5%) | | | | |
| ll | 48 (81.4%) | | | | |
| III | 3 (5.1%) | | | | |
| IV | 0 | | | | |
| Type of hernia (according to EHS classification): | | | | | |
| primary ventral, width ≥10 cm average width of hernia defect, cm | 21 (35.6%) 12.06 ± 1.91 | | | | |
| midline, epigastric | 4 (6.8%) | | | | |
| midline, umbilical | 17 (28.8%) | | | | |
| lateral, spigelian | 0 | | | | |
| lateral, lumbar | 0 | | | | |
| incisional ventral average width of hernia defect, cm | 38 (64.4%) 15.46 ± 1.09 | | | | |
| M1 midline, subxiphoidal | 0 | | | | |
| M2 midline, epigastric | 8 (13.6%) | | | | |
| M3 midline, umbilical | 17 (28.8%) | | | | |
| M4 midline, infraumbilical | 5 (8.5%) | | | | |
| M5 midline, suprapubic | 0 | | | | |
| L1 lateral, subcostal | 1 (1.7%) | | | | |
| L2 lateral, flank | 2 (3.4%) | | | | |
| L3 lateral, iliac | 3 (5.0%) | | | | |
| L4 lateral, lumbar | 2 (3.4%) | | | | |

Note. ASA, American Association of Anesthesiologists; EHS, European Hernia Society; N - the volume of the research sample; the data are presented as M±SD or abs. (%).

tion for surgery. The limited number of observations, the heterogeneity of the methods of performing the procedure and the combination of BTA injections with other interventions (progressive pneumoperitoneum (PP)) determine the low level of evidence of the BTA effectiveness in the treatment of large and giant VH [12].

One of the main effects expected from the BTA injections is the increase in the length of the lateral abdominal muscles and the possibility of avoiding the component separation when suturing large primary and incisional hernia defects [15, 16].

AIM

The aim of the present research is to investigate the effectiveness of using BTA in a total dose of 100 IU as the preparation of patients with primary and incisional

ventral hernias before the planned laparoscopic IPOM hernioplasty with the hernia defect suturing.

MATERIALS AND METHODS

GENERAL CHARACTERISTICS OF PATIENTS

The prospective study included 59 patients with VH who were treated from June 2017 to December 2022. All patients were diagnosed with a large size primary or incisional VH (hernial defect more than 10 cm). The type and size of hernia defects were determined according to the classification of European Hernia Society (2009) [17]. An average age of the patients was 59.13 ± 9.07 years. The body mass index of the patients ranged from 24 to 42 kg/m². Detailed characteristics of patients are presented in Table 1.



Fig. 1. Foto of BTA injections into the muscles of the anterior abdominal wall.

a - general view of points for injection on left side of the abdominal wall, b - view of the one point injection under the ultrasound control,

c - view of the needle connected to the neurostimulator and syringe with BTA.

THE BTA INJECTION TECHNIQUE

The use of BTA in the treatment of VH currently belongs to the "off-label use" category. The conduct of this study was examined and approved by the Medical Ethics Committee of Bogomolets National Medical University. All patients in the study gave written informed consent for use of BTA in preoperative preparation for surgical treatment of VH.

All patients received BTA injections in the muscles of the anterior abdominal wall in the preoperative period. The introduction of BTA was navigated under ultrasound control in real time. The procedure was made under double control using an injection needle attached to a neurostimulator Stimuplex HNS-12 (B. Braun, Melsungen, Germany), to improve the accuracy of injecting BTA directly into the muscle tissue.

The first step was to perform an ultrasound examination of the anterior abdominal wall, to determine the location, number and size of the hernial defect. After that the 6 points for BTA injections into the transverse, external and internal oblique muscles of the abdomen on left and right side were determined, 1 point in each of the muscles. A puncture of the selected muscle under ultrasound control was performed. With the help of a neurostimulator and visual control, the location of the end of the injection needle in the thickness of the selected muscle was verified, after which the administration of BTA was started. The total dose of the injected BTA per patient was 100 IU (Botoxâ, Allergan, USA) diluted in 20 ml of 0.9% sodium chloride solution. As a basis, the following method of BTA administration into the muscles of the anterior abdominal wall was chosen, a total into 6 injection points:

- the right external oblique muscle of the abdomen

- along the line between the anterior axillary and mid-clavicular lines 4 cm above the navel on the right, 15 IU (3 ml of solution),

- the right transversus abdominis muscle – along the right mid-clavicular line at the level of the navel, 15 IU (3 ml of solution),

- the right internal oblique muscle of the abdomen along the right mid-clavicular line 3 cm below the navel, 20 IU (4 ml of solution),

- the left external oblique muscle of the abdomen along the line between the anterior axillary and mid-clavicular lines 4 cm above the navel on the left, 15 IU (3 ml of solution),

- the left transversus abdominis muscle – along the left mid-clavicular line at the level of the navel, 15 IU (3 ml of solution),

- the left internal oblique muscle of the abdomen – along the left mid-clavicular line 3 cm below the navel, 20 IU (4 ml of solution) (Fig. 1).

THE CHARACTERISTIC OF COLLECTED DATA

The size, number and localization of hernia defects were determined by ultrasound examination. Also, the patients underwent computed tomography with 3D modeling of the abdominal cavity and determination of the volume of the abdominal cavity, the volume of the hernial sac, the size of the hernial defect, the length and thickness of the muscles of the anterior abdominal wall before and 4 weeks after the administration of BTA.

Intra-abdominal pressure was measured at least twice: for the first time – after the end of the injection of BTA, for the second time – intraoperatively. In both cases, the measurement was performed using an in-

| Turie is changes in the size of the abaominat than and herma before and after bin |
|---|
|---|

| Indicator | Before BTA | After BTA | Р |
|---|-------------------|-------------------|--------|
| Width of the hernia defect, cm | 13.31 ± 2.34 | 8.81 ± 2.46 | <0.001 |
| Length of the hernial defect, cm | 12.43 ± 4.86 | 12.28 ± 4.87 | 0.048 |
| Volume of the abdominal cavity, cm ³ | 9251.64 ± 2971.83 | 9616.13 ± 2907.49 | 0.008 |
| Volume of the hernia sac, cm ³ | 426.05 ± 303.24 | 357.46 ± 258.84 | 0.005 |
| Length of the abdominal wall, cm: | | | |
| - right side | 25.21 ± 6.51 | 26.88 ± 7.17 | 0.027 |
| - left side | 22.78 ± 6.05 | 24.43 ± 6.59 | 0.006 |
| Thickness of the abdominal wall, cm: | | | |
| - right side | 1.69 ± 0.13 | 1.41 ± 0.15 | <0.001 |
| - left side | 1.65 ± 0.38 | 1.55 ± 0.40 | 0.017 |

Note. Data are presented as $M \pm SD$ or abs. (%).



Fig. 2. Computed tomography scans before (a) and after (b) the introduction of BTA with 3D modeling of the volumes of the hernial sac and abdominal cavity.

direct method by inserting a Foley catheter into the urinary bladder.

All patients underwent surgery 4-5 weeks after BTA injection. Laparoscopic surgery (hernioplasty according to the IPOM method with suturing of the hernia defect) was planned for all patients.

Introduction of BTA under the ultrasound control was performed by one surgeon who specialized in ultrasound diagnostics. Evaluation of all CT results and size calculation was performed by a single radiologist.

The follow-up examinations were carried out after 2 weeks, 1 month, 1 year after operation. During control visits the ultrasound examination of the anterior abdominal wall was also carried out to detect complications and a possible recurrence of the hernia, which

was not diagnosed during an objective examination.

STATISTICAL ANALYSIS

Data were analysed with the statistical package IBM SPSS Statistics Base (version 22). All results were considered statistically significant at a value of p<0.05. Quantitative data are presented as mean (M) \pm standard deviation (SD), unless otherwise stated. The normality of the data distribution was checked using the chi-square test (p>0.05). For normally distributed data, comparisons were made using paired Student's t-test for related samples. For non-normally distributed data the comparison was performed using the Wilcoxon sign rank criterion for related samples.



Fig. 3. Computed tomography scans before (a) and after (b) the introduction of BTA with determination of the length of the abdominal wall on the right and left side.

RESULTS

Before administration of BTA the average width of the hernia defect was 13.31 ± 2.34 cm (min – 10 cm, max – 18.9 cm). In 18 (30.5%) patients with incisional hernias the width of the hernia defect exceeded 150 mm. The average length of the hernial defect was 12.43 ± 4.86 cm (min – 7.20 cm, max – 20.1 cm). Eight (13.6%) patients had left-sided hernias, 6 (10.2%) patients had right-sided hernias. In 5 (8.5%) patients hernia was recurrent.

In 14 (23.7%) patients an asymmetric location of the hernial defect relative to the midline and unilateral deformation of the anterior abdominal wall were observed. In these patients the introduction of BTA could not be carried out at previously planned points. During the ultrasound examination, lateral displacement of the muscles was observed in these patients, which required individual selection of BTA injection points with optimal visualization of the necessary muscle.

In all patients, the movement of the needle in the tissues during muscle puncture was carried out under the control of a 4-15 MHz linear ultrasonic sensor. When placing the tip of the needle in the thickness of the necessary muscle, before introducing BTA, the neurostimulator was turned on to check the position of the needle direct in muscles tissue. At the same time, a subjective sensation in the patient and visual signs of twitching of the punctuated muscle on the monitor of the ultrasound apparatus were checked. In 32 (54.2%) patients there was at least one episode of absence of punctuated muscle contraction with a clear visual placement of the needle tip in the thickness of this muscle. Such situation required the correction of the needle tip placement or a repeated puncture attempt. The need for correction of the placement of the needle

in two puncture points occurred in 14 (23.7%) patients, in three or more puncture points – in 5 (8.5%) patients. There were no complications during or after BTA injection into the muscles of the anterior abdominal wall.

After the introduction of BTA, the average width of the hernia defect decreased by 4.5 ± 1.11 cm (min – 1.4 cm, max – 6.5 cm), which was 34.66 ± 9.01 % of the primary width of the hernia (p<0.001). An average length of the hernia defect after the introduction of BTA also decreased (p=0.048), but the changes were minimal (Table 2).

After the introduction of BTA, a significant increase in the volume of the abdominal cavity was observed. An average increase in the volume of the abdominal cavity after the administration of BTA was $364.49 \pm 380.14 \text{ cm}^3$ (min – 33.90 cm^3 , max – 1034.0 cm^3), which was $4.04 \pm 4.55 \%$ from the initial indicator (p=0.008). At the same time, the opposite changes in the volume of the hernial sac decreased an average $68.59 \pm 47.94 \text{ cm}^3$ (min – 27.60 cm^3 , max – 160.0 cm^3), which was $21.43 \pm 16.57 \%$ from the initial indicator (p=0.005) (Fig. 2).

The length of the abdominal wall was measured from the lateral margin of the quadratus lumborum muscle to the medial margin of the rectus muscle from the comparable axial image (section) (Fig. 3).

After the injection of BTA, a significant increase in the length of the abdominal wall and a decrease in its thickness were observed. On the right side, the average increase in the length after BTA was 1.78 ± 1.26 cm (min – 0.1 cm, max – 3.81 cm), which was 6.52 ± 4.49 % from initial length (p=0.027). The same tendency was on the left side – 1.84 ± 11.47 cm (min – 0.23 cm, max – 3.6 cm) after BTA, equivalent to 7.25 ± 4.50 % from initial one

(p=0.006). On the right side, the average decrease in the thickness of the abdominal wall after BTA was 0.28 \pm 0.15 cm (min – 0.08 cm, max – 0.50 cm), which was 16.55 \pm 8.17% from the initial indicator (p<0.001), on the left side – 0.11 \pm 0.10 cm (min– 0.01 cm, max – 0.27 cm), which was 6.67 \pm 5.77% from the initial thickness (p=0.017).

Surgery was performed 4 weeks after the administration of BTA in 47 (79.7%) patients, at 5 weeks – in 12 (20.3%) patients. 50 (84.7%) patients underwent laparoscopic hernioplasty with intraabdominal mesh introduction and fixation. 7 (11.9%) patients underwent open IPOM hernia repair: laparotomy, resection of hernia sac, intraabdominal mesh introduction and fixation by transaponeurotic separate sutures, open suturing of the aponeurosis of the rectus abdominis muscle. In all cases with intraabdominal mesh positioning the composite mesh was used, without draining of abdominal cavity. 2 (3.4%) patients with incisional hernias underwent laparotomy, adhesiolysis, hernioplasty using the sublay method, drainage of the wound according to Redon technique.

During laparoscopic hernioplasty the first trocar was installed using optical type one or by "open" technique according to Hassan's method. We consider it is necessary to use just such techniques, which allows to minimize the risk of internal organs injury in case of their fixation to the anterior abdominal wall. Suturing of hernia defect was made by applying separate subcutaneous transaponeurotic sutures (IPOM) in 27 (54%) patients and by open suturing trough small incision directly under the hernia defect (IPOM+) – in 23 (46%) patients. Tightening of applied sutures was performed extracorporeally when the intraabdominal pressure was reduced.

In all cases (n=57) with intraabdominal mesh positioning the composite meshes with anti-adhesive coating were used, while in 19 (33.4 %) cases – based on polypropylene, in 38 (66.7 %) cases – based on polyester. In 2 cases open hernia repair by sublay technique were performed, a light polypropylene mesh was used. The size of the mesh was chosen individually in all cases, depending on the size and number of defects of the anterior abdominal wall, but was not less then 20x25cm according to the mesh overlap of the margins of the hernia defect 5 cm or more.

Fixation of the mesh during open hernia repair (n=9) was performed typically with separate polypropylene non-absorbable sutures (open IPOM and open sublay surgery). During laparoscopic hernioplasty (n=50) mesh fixation was carried out in 2 stages. The first stage was fixation of the mesh to the anterior abdominal wall at 4 points using subcutaneous transaponeurotic sutures.

On second stage the mesh was fixed by tacks using the "double crown" technique (absorbable tacks – in 21 (42%) patients, non-absorbable – in 29 (58%) patients).

The laparoscopic technique of hernioplasty did not involve drainage of wounds and the abdominal cavity. The postoperative wound was drained according to Redon technique in all 2 cases after open hernioplasty using the sublay technique and in 3 cases after open IPOM hernia repair. The drain was removed on the 3-4th postoperative day with minimal daily discharge from the drain. Operation duration was 134.20 ± 41.6 min for laparoscopic hernia repair, 181.4 ± 15.74 min for open IPOM operation and 172.50 ± 10.61 min for open sublay surgery.

Measurement of intra-abdominal pressure was performed by an indirect method immediately after the administration of BTA and at the end of the surgical intervention. Indicators of the intra-abdominal pressure level in both cases in all patients fluctuated within the normal range. All patients underwent a control ultrasound examination in 2 weeks, 1 month after surgery and 23 patients also underwent it 1 year after surgery. No recurrence of the hernia was detected during the observation period of 12 months.

DISCUSSION

Laparoscopic hernioplasty for VH can reduce the risk of postoperative complications, especially in overweight patients. However, the size of the hernia defect can be a limiting factor when choosing a laparoscopic method of hernioplasty. Large hernia defects of the anterior abdominal wall with a width of more than 10 cm may require component separation for adequate suturing of the hernia, avoiding tension and reducing the risk of compartment syndrome. The need for component separation makes it necessary to choose an open method of performing hernioplasty.

Chemical separation of the abdominal wall with the use of BTA opened new opportunities for laparoscopic hernioplasty of VH and also made it possible to avoid the use of traumatic component separation in open surgery for giant VH. Since the appearance of the first publication in 2009, according to the electronic database PubMed, more than 80 publications were published about the use of BTA in the treatment of VH, including 2 systematic reviews of the literature [16, 18] and 3 combinations of a systematic review and meta-analysis [1, 19, 20].

In a systematic review Wegdam et al. analyzed the data of 14 published studies that were conducted from 2009 to 2020 and included the results of using BTA (559 patients) and the combination of BTA with PP

(267 patients). The most frequently used dose of Botoxâ is 300 IU [16]. When evaluating the dosage of BTA, it is necessary to consider that Botoxâ and Dysportâ have different potencies, with a commonly referenced dosing ratio ranging from 1:2 to 1:3. However, this ratio may vary based on clinical application and individual patient response [21]. According to the results of the conducted studies, it was noted that the use of a total doses of BTA 100 IU or 150 IU were ineffective [16].

Only 2 studies were presented, in which the use of a total dose of BTA less than 200 IU was indicated [22, 23]. Chávez-Tostado et al. [22] reported the use of a total dose of BTA 100 IU. In this study 50% of patients (n =7) have a reduction in the diameter of the hernia defect after BTA, and only for 22% (n = 3) of patients the component separation was performed to restore the integrity of the aponeurosis. At the same time, in 50% of patients, the size of the hernial defect was more than 15 cm. There were no data on the correlation between the diameter of the hernial defect and the percentage of its reduction after the introduction of BTA. It can be assumed that the low efficiency of using this dose of BTA is connected precisely with the choice of the same dose for hernia defects of different sizes (from 10 to 34.3 cm) and different deformation of the muscles of the anterior abdominal wall. In both studies [22, 23] open hernioplasty was performed and it is not indicated how the lateral length of the muscles of the abdominal wall changed.

In one publication, which was not included in the above-mentioned literature reviews, Mourad et al. presented the results of treatment of a patient with an incisional ventral hernia using preoperative administration of BTA. A total dose of 100 IU of BTA was sufficient for subsequent open hernioplasty with suturing of the hernia defect [24].

Tang et al. also used a BTA in dose of less than 200 IU, namely 100 IU and 150 IU. The administration of BTA in all 22 patients was combined with PP and the dynamics of changes in the length of the muscles of the anterior abdominal wall, the volume of the hernial sac and the abdominal cavity were analyzed. In all patients the width of the hernia defect was more than 10 cm, and in 2 (9%) patients it exceeded 15 cm. At the same time, all patients managed to perform primary laparoscopic hernioplasty with suturing of the hernia defect [25]. But it was not indicated in which case a dose of BTA 100 IU, or 150 IU was chosen. It is also impossible to evaluate the effectiveness of the use of BTA itself since its combination with PP does not make it possible to estimate the effect of each of the methods separately on the length of the muscles of the anterior abdominal wall.

According to the results of our study, we concluded that the use of only BTA injections has a significant

effect on the length of the muscles of the anterior abdominal wall. But the amount of muscle lengthening is smaller compared to the results of the study when BTA administration is combined with PP. Thus, in our study, muscle length increased by 1.8 cm on each side on average, while in Tang's study et al. this indicator reached 4.1 cm, varying in the range from 1.5 to 7.2 cm on each side [25]. Rodriguez-Acevedo et al. also reports a significant increase in the length of the muscles of the abdominal wall both when BTA is administered and when BTA is combined with PP [26]. At the same time, only the introduction of BTA (200 or 300 IU) lengthens the muscles by an average of 4.2 ± 2.5 cm, while the combination of BTA with PP shows even lower values $(3.7 \pm 1.9 \text{ cm})$, although the difference is not statistically significant. Yurtkap et al. shows a more significant lengthening of the abdominal muscles when combining BTA and PP (4 cm) compared to BTA (2-3 cm), although it does not indicate the statistical significance of this difference and emphasizes the risk of developing complications when using PP [27]. Bueno-Lledó et al. reports the results of currently the largest number of observations (100 patients) of the use of BTA and PP with loss of domain hernias [28]. In his study, he does not separately analyze the effectiveness of BTA and the change in the length of the muscles of the abdominal wall but indicates the importance of evaluating the change in the diameter of the hernial defect and the change in the ratio of herniary volume to abdominal cavity volume. In all these studies a total dose of BTA, which was administrated before the operation in every case, was more than 200 IU [25-28].

Currently, there is no standardized protocol for chemical separation using BTA before VH repair. The issues of BTA dose selection, the number of injection points, the number of layers (muscles) into which BTA should be injected, methods of visualization and control of the BTA injection remain debatable. BTA is injected into both 3 [29] and 5 [14] points on each side of the abdominal wall. At the same time, the difference in the prevalence of effectiveness of one of the methods is uncertain [27]. In our study, in all cases, 3 injection points were sufficient to visualize each of the lateral muscles of the abdominal wall and perform their safe puncture. The use of double control of the injection site (ultrasound and neurostimulator) is mandatory in our case since visual control of the placement of the needle tip does not always ensure the accuracy of BTA injection directly into the muscle. This may be due to excessive development of fibrous tissue in deformed muscles of the abdominal wall due to large hernial protrusion.

We would also like to highlight that indirectly measuring intraabdominal pressure following BTA injections is an invasive procedure, potentially leading to urinary complications. In our study, in all patients the maximum size of the hernial defect did not exceed 20 cm. And in all cases the intraabdominal pressure didn't increase above normal range. Therefore, we believe that indications for intraabdominal pressure assessment should be determined individually in case of suspicion of a high risk of developing compartment syndrome (the size of the hernial defect is more than 20 cm, the high ratio of herniary volume to abdominal cavity volume, loss of domain hernia and others).

There are also no clear indications for the use of BTA, no patient selection algorithm for the administration of BTA in the preoperative period, and the clearly defined time frame for subsequent hernioplasty (from administration on the day of surgery to 6 weeks before surgery). According to the results of a systematic review and meta-analysis of literature, van Rooijen et al. suggests using BTA in the presence of fibrotic changes in the muscles of the anterior abdominal wall or their thickening. In case of loss of domain PP should be chosen [24]. Bittner et al. notes the possibility of serious complications when using PP and better tolerability of BTA [12]. At the same time, the significance of a statistically difference in the lengthening of the muscles of the abdominal wall when comparing these methods is controversial [25, 26]. However, according to Bittner et al., the use of only BTA for large hernias does not allow to suture the hernia defect without component separation [12]. In our study, in all patients it was possible to suture the hernia defect without component separation, but in 15.3% of cases the open hernia repair was done. It should be considered that we did not include in the study patients with a defect width of more than 20 cm and loss of domain.

CONCLUSIONS

The administration of BTA injections in the muscles of the anterior abdominal wall makes it possible to perform laparoscopic IPOM hernioplasty for patients with large size VH. BTA injections in the preoperative period reduce the number of patients for open hernia surgery and allow to avoid the traumatic technique of component separation during VH repair. It is necessary to standardize the method of administering BTA, to study the effectiveness of different doses of BTA on changes in the length of the muscles of the anterior abdominal wall and to determine the indications for the use of a combination of BTA with other methods of preoperative preparation of patients with large and giant VH.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Tetiana V. Tarasiuk

Bogomolets National Medical University 13 Taras Shevchenko Boulevard, 01601 Kyiv, Ukraine e-mail: tara-tanya@ukr.net

ORCID AND CONTRIBUTIONSHIP

Tetiana V. Tarasiuk: 0000-0001-6629-3908 A B C D F Oleksandr Yu. loffe: : 0000-0002-1306-7920 A E F Oleksandr M. Chukanov: 0000-0003-1081-9573 B Mykola S. Kryvopustov: 0000-0003-4978-4873 B C Oleksandr P. Stetsenko: 0000-0002-2219-653X E

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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Health-improving effect of running for students of technical specialties

Yurii V. Novytskyi, Zoia V. Syrovatko, Tetiana H. Kozlova, Anna Yu. Chekhovska, Oleksandr Ye. Salamakha, Vadym M. Mykhailenko, Oksana M. Chychenova

NATIONAL TECHNICAL UNIVERSITY OF UKRAINE "IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE", KYIV, UKRAINE

ABSTRACT

Aim: To study the dynamics of indicators of the functional state and health of technical specialties students during their long-term running engagement. **Materials and Methods:** The research involved 112 students (59 men and 53 women) aged 17-20 years. Two groups of students were formed: group 1 included students who, in addition to compulsory academic physical education training sessions, were not engaged in any type of motor activity on their own; group 2 included students who independently were engaged in recreational running 3 times a week in extracurricular time.

Results: It was found that during the research period, both male and female students who were independently engaged in recreational running in extracurricular time showed a significant improvement of such indicators as resting heart rate, vital capacity of the lungs, duration of breath holding during inhalation and exhalation, duration of heart rate recovery after standard exercise, level of endurance development, level of physical health.

Conclusions: The positive influence of independent running with moderate intensity on the functional state and health of students of technical specialties has been proved. The low efficiency of the physical education system in Ukraine and, accordingly, the insufficient level of motor activity, indicators of functional status, and health of students who, in addition to academic physical education training sessions, did not exercise on their own, were also confirmed.

KEY WORDS: health, functional state and, motor activity, running, students

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INTRODUCTION

Human life and health are the highest social values, which should be considered in determining all other values and benefits. The creation of conditions by the state for the realization of the citizen's right to health care contributes to the progressive socio-economic development of the state and strengthens its security [1, 2].

The existing system of higher educational institutions (HEIs) in Ukraine places high demands on students' mental and physical working capacity and health. High academic loads and low motor activity, irrational diet and bad habits, stressful situations, and unsatisfactory organization of physical education in Ukrainian HEIs hurt students' health [3, 4].

A significant number of scientists [5, 6] argue that the main problem of the constant deterioration of the health of Ukrainian students is the lack of daily motor activities. That is, the chronic deficiency of motor activities in the lifestyle of modern students is a real threat to their health. At the same time, according to experts [7, 8], the solution to this problem is possible by including aerobic exercises of moderate intensity in both academic physical education training sessions at HEIs and independent physical exercises in extracurricular time.

Studies by many scientists [9, 10] have shown that regular use of aerobic exercise promotes the effective development of endurance while having a positive effect on the cardiorespiratory system and the emotional state of students. From a physiological point of view, endurance is characterized as the ability to perform work for a long time at the required level of intensity, as well as the ability to fight fatigue [11]. Endurance allows you to perform work for a long time, which places high demands on the cardiovascular system, respiratory system, and central nervous system [12]. The research by experts [13] confirms the fact that when a certain level of endurance development is reached, changes occur at the functional level in the body, primarily in the main life support systems (cardiovascular, and respiratory). The development of endurance allows to effectively form reserves of adaptation of the body and ensure their high working capacity, to form perfect mechanisms of regulation of vascular tone in conditions of nervous and emotional stress and thus to ensure prevention of cardiovascular diseases. It is believed that aerobic exercises performed for a long time (10-30 minutes) help to strengthen the cardiovascular and respiratory systems; because oxygen, glycogen, and fat are processed into energy [14].

According to many scientists [15, 16], recreational running is a universal means of increasing students' motor activities. More than 100 million people of all ages on our planet use running as a health-improving means [17]. The authors point to positive changes in health through running, namely: increasing the body's resistance to adverse environmental factors, normalizing body weight, strengthening the musculoskeletal system, and increasing endurance [18]. The literature [19] considers two directions in terms of the effectiveness of running on the human body: general and special. The general effect of running is associated with changes in the functional state of the central nervous system, compensation for missing energy expenditure, functional shifts in the circulatory system (increased oxygen capacity of the blood, its protective functions), reduced morbidity (increased immunity), normalization of body weight, strengthening the body's resistance to adverse environmental factors. Many scientists emphasize the increase in creative activity and the fruitfulness of scientific research through recreational running. A special effect of running training engagement is to increase the functional capabilities of the cardiovascular system and aerobic performance (working capacity) of the body. Given the above, it is important to study the impact of running on the functional state and health of student youth in Ukraine.

AIM

The aim is to study the dynamics of indicators of the functional state and health of technical specialties students during their long-term running engagement.

MATERIALS AND METHODS

The research involved 112 students (59 men and 53 women) of the main division aged 17-20 years who entered the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (Kyiv, Ukraine) in 2022 at the Faculty of Radio Engineering, Faculty of Chemical Engineering and Faculty of Electric Power Engineering and Automatics. The research was conducted during 2022-2024. Two groups of students were formed: group 1 included students who, in addition to compulsory academic physical education training sessions at the HEI, were not engaged in any type of motor activity on their own (31 males, 29 females); group 2 included students who independently were

engaged in recreational running 3 times a week in extracurricular time (28 males, 24 females). All students in group 2 did not belong to sports clubs; the main motivations for independent running were: getting joy and pleasure, promoting health, spending extra calories, and emotional release. The volume of running load was from 2 to 7 km, the pace was slow, and the intensity was moderate (heart rate did not exceed 150 beats per minute). Groups 1 and 2 were formed at the beginning of the academic year (September 2022) at the student's request after an introductory briefing by the instructors of the Department of Health and Sports Technologies.

The methods of investigation: analysis and generalization of the scientific and methodological literature, testing, methods of mathematical statistics. 26 sources on the topic of the article from the scientometric databases PubMed, Scopus, Web of Science Core Collection and others were analyzed. The testing involved determining the following indicators of students' functional state and health: resting heart rate (RHR), blood pressure (systolic and diastolic), vital capacity of the lungs (VC), timed inspiratory (Stange test) and expiratory (Genchi test) capacity, duration of heart rate recovery after standard exercise (Martine-Kushelevsky test), 1 km run (level of endurance development), level of physical health (methodology of H.L. Apanasenko). Testing was conducted at the beginning (September 2022) and at the end (May 2024) of the research.

Statistical processing of the obtained results was carried out by methods of variation statistics using the STATISTICA 6.1 software package (number AGAR909E-415822FA). The compliance of the data distribution with the normal law (Gauss' law) was assessed using the Shapiro-Wilk W-test. The results were presented as (M \pm m), where M is the arithmetic mean, m is the error of the arithmetic mean. The authenticity of the difference between the indicators of students of studied groups was determined by Student's t-test. The level of statistical significance of the research results was chosen as p < 0.05.

This study complies with the ethical standards of the Act of Ukraine "On Higher Education" No. 1556-VII dated 01.07.2014 and the Letter from the Ministry of Education and Science of Ukraine "On the Academic Plagiarism Prevention" No. 1/11-8681 dated 15.08.2018. Also, this study followed the regulations of the World Medical Association Declaration of Helsinki – ethical principles for medical research involving human subjects. Informed consent was received from all individuals who took part in this research.

| Studied indicators | Stages | Group 1 (n=31) | Group 2 (n=28) | Significance of the differences | | |
|----------------------------------|-----------|-------------------|-------------------|---------------------------------|--|--|
| | Beginning | 69.9±0.76 | 70.1±0.85 | t=0.18; P>0.05 | | |
| кнк, орт | End | 71.2±0.81 | 68.7±0.79 | t=2.21; P<0.05 | | |
| | Beginning | 119.7±0.58 | 119.9±0.67 | t=0.23; P>0.05 | | |
| Systolic blood pressure, mm Hg | End | 120.5±0.62 | 118.8±0.65 | t=1.89; P>0.05 | | |
| | Beginning | 72.1±0.69 | 72.8±0.77 | t=0.68; P>0.05 | | |
| Diastolic blood pressure, mm Hg | End | 72.9±0.71 | 71.1±0.74 | t=1.76; P>0.05 | | |
| | Beginning | 3896.3±65.04 | 3912.9±78.92 | t=0.16; P>0.05 | | |
| vc, mi | End | 4067.6±67.18 | 4308.1±73.70 | t=2.41; P<0.05 | | |
| Charles and the start | Beginning | 56.8±1.12 | 57.3±1.18 | t=0.31; P>0.05 | | |
| Stange test, s | End | 59.2±1.07 | 64.4±1.14 | t=3.35; P<0.01 | | |
| Canabitest e | Beginning | 35.9±0.62 | 36.1±0.68 | t=0.22; P>0.05 | | |
| Genchi test, s | End | 38.6±0.64 | 42.8±0.65 | t=4.60; P<0.001 | | |
| | Beginning | 127.4±2.54 | 125.2±2.72 | t=0.59; P>0.05 | | |
| Martine-Rushelevsky test, s | End | 122.9±2.57 | 114.7±2.68 | t=2.21; P<0.05 | | |
| 1 1/200 11/200 0 | Beginning | 257.2±2.15 | 251.9±2.26 | t=1.70; P>0.05 | | |
| T km run, s | End | 248.4±2.18 | 237.8±2.21 | t=3.41; P<0.01 | | |
| | Beginning | 3.46±0.45 | 3.79±0.56 | t=0.46; P>0.05 | | |
| Level of physical health, points | End | 4.09±0.49 | 6.92±0.54 | t=3.88; P<0.01 | | |

Table 1. Dynamics of the functional state and health indicators of male students in groups 1 and 2 during the research (n=59, M±m)

Note: n – number of students, M – arithmetic mean, m – error of the arithmetic mean, t – Student's t-test value, P – significance of the difference between the indicators of groups 1 and 2.

RESULTS

The results of the assessment of functional state and health indicators of students in groups 1 and 2 are presented in Table 1 (men) and Table 2 (women). It was found that at the beginning of the research, all indicators in groups 1 and 2, both among male and female students, did not differ significantly (P > 0.05). This indicates the homogeneity of the groups and the absence of any special selection for groups 1 and 2. Heart rate and blood pressure indicators were used to study the functional capabilities of the cardiovascular system of students. The analysis of resting heart rate showed that at the end of the research, this value was significantly better in group 2 than in group 1, by 2.5 beats/min among men (P < 0.05) and by 2.8 beats/min among women. At the same time, in group 2 there is a tendency to improve heart rate during the research period, and in group 1, on the contrary, to deteriorate. It was also found that all values of heart rate in students of group 2 (males, females) were in the range of 60-80 beats/min. That is, students who were engaged in recreational running did not show signs of tachycardia, unlike group 1. It testifies to the economic activity of the cardiovascular system of students in group 2 that is characteristic for representatives of sports with predominant development of endurance in which sports activity is carried out in an aerobic mode of energy supply.

The study of blood pressure (systolic and diastolic) shows that the indicators of functional capabilities of students in group 2 at the end of the research were slightly better than in group 1, but no significant difference was found between them (P > 0.05). The VC indicators characterize the maximum amount of air exhaled by students after the deepest breath and the state of the external respiratory apparatus. Thus, the analysis of the VC indicators showed that at the end of the research, male students in group 2 had a value significantly higher than in group 1, by 240.5 ml (P < 0.05), and female students - by 233.8 ml (P < 0.05). It is also worth noting that during the research period, both groups improved their VC indicators, but the changes were not significant (P > 0.05) in group 1, and they were significant (P < 0.01) in group 2. This confirms the fact that students engaged in recreational running have a higher level of functional state of the respiratory system. These conclusions are also confirmed by the results of breath-holding tests, where students of group 2 (both men and women) revealed significantly better indicators at the end of the research compared to group 1 (P < 0.05-0.001). This allows us to talk about the ability of students engaged in running to work effectively in

| Studied indicators | Stages | Group 1 (n=31) | Group 2 (n=28) | Significance of the differences |
|----------------------------------|-----------|-------------------|-------------------|---------------------------------|
| | Beginning | 69.2±0.82 | 69.3±0.91 | t=0.08; P>0.05 |
| кнк, брт | End | 70.3±0.83 | 67.5±0.86 | t=2.34; P<0.05 |
| Systelic blood prossure mm Ha | Beginning | 117.4±0.64 | 118.1±0.75 | t=0.71; P>0.05 |
| Systolic blood pressure, mm Hg | End | 118.8±0.66 | 118.0±0.74 | t=0.81; P>0.05 |
| | Beginning | 70.3±0.76 | 70.5±0.81 | t=0.18; P>0.05 |
| Diastolic blood pressure, mm Hg | End | 70.7±0.75 | 70.2±0.79 | t=0.46; P>0.05 |
| | Beginning | 2919.2±78.52 | 2925.2±84.47 | t=0.05; P>0.05 |
| ve, iii | End | 3055.8±80.06 | 3289.6±82.90 | t=2.03; P<0.05 |
| Store so tost s | Beginning | 49.5±1.29 | 50.2±1.36 | t=0.37; P>0.05 |
| Stange test, s | End | 50.4±1.33 | 55.8±1.31 | t=2.89; P<0.05 |
| Conchi tott c | Beginning | 32.7±0.73 | 31.9±0.84 | t=0.72; P>0.05 |
| Genchi test, s | End | 34.1±0.74 | 38.3±0.82 | t=3.80; P<0.01 |
| Martina Kuchalayslaytast s | Beginning | 136.1±2.79 | 134.7±2.94 | t=0.35; P>0.05 |
| Martine-Rushelevsky test, s | End | 132.8±2.65 | 123.7±2.86 | t=2.33; P<0.05 |
| 1 km kun s | Beginning | 304.1±2.35 | 298.8±2.49 | t=1.55; P>0.05 |
| | End | 295.8±2.33 | 276.2±2.42 | t=5.83; P<0.001 |
| Lovel of physical boolth paints | Beginning | 3.85±0.81 | 4.03±0.94 | t=0.15; P>0.05 |
| Level of physical health, points | End | 4.61±0.79 | 7.15±0.83 | t=2.22; P<0.05 |

Table 2. Dynamics of the functional state and health indicators of female students in groups 1 and 2 during the research (n=59, M±m)

Note: n - number of students, M - arithmetic mean, m - error of the arithmetic mean, t - Student's t-test value, P - significance of the difference between the indicators of groups 1 and 2.

conditions of insufficient oxygen in the body. Studies of the duration of HR recovery to baseline values after a standard test load indicate that in students of group 2 of both sexes, this value was significantly better at the end of the research than in students of group 1, by 8.2 and 9.1 s, respectively (P < 0.05). At the same time, the time of heart rate recovery in students of group 2 improved significantly (P < 0.001) during the research period, in contrast to group 1.

The analysis of students' results in the 1 km run showed that the level of endurance development was significantly better in group 2 than in group 1 at the end of the research, by 10.6 s among men (P < 0.01) and by 19.6 s among women (P < 0.001). Moreover, group 2 revealed a more pronounced significant improvement in results in the 1 km run during the experiment (P < 0.001). This proves the effectiveness of aerobic exercise during recreational running in improving the level of students' endurance. According to the results of the physical health assessment, it can be concluded that students of group 2 had significantly better health levels than in group 1 at the end of the research, by 3.13 points among men (P < 0.01) and by 3.12 points among women (P < 0.05). During the research period, the level of health in group 2 improved significantly (P < 0.001), while it did not change significantly (P > 0.05) in group 1. All this shows the positive impact of independent running training sessions with moderate intensity on the improvement of the functional state and health of student youth.

DISCUSSION

In recent years, against the background of the intensification of the educational process in Ukrainian HEIs, there has been a tendency to reduce the amount of motor activity of students, which negatively affects their physical condition, and therefore the issues of formation, preservation, and strengthening of the health of student youth are of particular social importance [20]. A significant role in optimizing this situation is played by the use of simple, affordable, and, at the same time, adequate and effective means of physical education in the everyday life of students, not only in academic physical education training sessions at HEIs but also during independent training sessions, to compensate for the deficit of their daily motor activity [21].

In recent years, many researchers [22-24] have addressed the problem of improving the process of physical education and increasing the effectiveness of physical education and health training sessions with students. To date, approaches to the organization of physical education training sessions for students focused on the formation of valeological values based on the use of adequate means and methods of physical culture have been proposed; models of sports and recreational activities of students based on the correction of the organization of the process of physical education in HEIs have been suggested; theoretical and methodological support for physical education of students of HEIs has been developed; several methods for normalizing loads of different directions based on individual interests and the level of the physical condition of students have been substantiated; approaches to the division of students into groups for physical education based on model characteristics of different levels of physical health have been proposed. At the same time, experts continue to note the deficit in students' motor activity, low levels of physical fitness, and physical health of modern students [6, 8]. Our research confirms the conclusions of many scientists about the insufficient level of indicators of the functional state and health of students who, in addition to academic physical education training sessions, did not exercise on their own. Instead, the positive effect of independent running on the health of students, both men and women, has been proven.

According to scientists [25], the main motivations for young people to engage in recreational running are: promoting health and disease prevention; increasing working capacity; enjoyment of the running process; desire to improve their running results (sports motivation); tribute to fashion (aesthetic motivation); desire for communication; desire to know their body, their capabilities; motivation for creativity, motivation for education and strengthening of the body. According to experts [19], running is a natural tranguilizer that works much better than medications. When examining middle-aged men and women engaged in recreational running, scientists found a significant increase in the content of red blood cells, hemoglobin, and lymphocytes in the blood, which increases the oxygen capacity of the blood and its protective functions [16]. In addition, an increase in immunoglobulins was found in the blood, which helps to reduce the incidence of disease. When analyzing the ability to work and the incidence of diseases among employees of various enterprises, it turned out that among people engaged in recreational running, the number of days of disability decreased from an average of 18 to 2 days per year [26]. The results of our research confirm the existence of a direct relationship between the level of motor activity (running) and the state of health of students. Particularly noticeable changes were observed in the performance of the cardiovascular and respiratory systems of the body, as well as the level of endurance development of students.

CONCLUSIONS

The positive influence of independent running with moderate intensity on the functional state and health of students of technical specialties has been proved. It was found that during the research period, both male and female students who were independently engaged in recreational running 3 times a week in the amount of 2 to 7 km at a heart rate of up to 150 beats per minute in extracurricular time showed a significant (P < 0.05-0.001) improvement of such indicators as resting heart rate, vital capacity of the lungs, duration of breath holding during inhalation and exhalation, duration of heart rate recovery after standard exercise, level of endurance development based on the results of the 1 km run, level of physical health. The low efficiency of the physical education system in Ukrainian HEIs and, accordingly, the insufficient level of motor activity, indicators of functional status, and health of students who, in addition to academic physical education training sessions, did not exercise on their own, were also confirmed.

Prospects for further research are aimed at studying the effectiveness of swimming training sessions on students' health.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Zoia V. Syrovatko

Igor Sikorsky Kyiv Polytechnic Institute 37 Beresteyskyi Prospect, 03056 Kyiv, Ukraine e-mail: szoyavolleyball@ukr.net

ORCID AND CONTRIBUTIONSHIP

Yurii V. Novytskyi: 0000-0002-5011-7034 A Zoia V. Syrovatko: 0000-0002-5752-9445 B D Tetiana H. Kozlova: 0000-0003-3096-3687 B C Anna Yu. Chekhovska: 0000-0002-0675-5004 D Oleksandr Ye. Salamakha: 0000-0002-4798-9800 B D Vadym M. Mykhailenko: 0000-0002-1001-1999 E Oksana M. Chychenova: 0000-0003-1551-9799 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Substantiation of the methodology for assessing the biological age of adolescents

Valery G. Arefiev¹, Olena V. Andrieieva², Oleksandr A. Arkhipov¹, Nataliia D. Mykhailova¹, Inna M. Liakhova³, Ivan M. Okhrimenko⁴, Lyudmila V. Moroz⁵

¹UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE

²NATIONAL UNIVERSITY OF UKRAINE ON PHYSICAL EDUCATION AND SPORT, KYIV, UKRAINE

³BORYS GRINCHENKO KYIV UNIVERSITY, KYIV, UKRAINE

⁴NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE

⁵SUMY STATE PEDAGOGICAL UNIVERSITY NAMED AFTER A. S. MAKARENKO, SUMY, UKRAINE

ABSTRACT

Aim: To substantiate the methodology for assessing the biological age of adolescent high schoolers (boys and girls).

Materials and Methods: Boys aged 14-15 (n = 102) and girls aged 12-13 (n = 101) were studied. The choice of these age groups is explained by the presence of the most significant individual differences in morphological and functional characteristics in these adolescents. Methods: anthropometry, somatometry, somatoscopy, tonometry, spirometry, dynamometry, Stange's test, Rufier and Robinson indices. The interaction of the results of different methods of assessing biological age was conducted on one sex-age sample using factor analysis (principal components method).

Results: It has been established that the biological age of adolescents can be reliably determined using a set of three components: an assessment of the level of physical development, the index of heterochronicity, and the degree of manifestation of secondary sexual characteristics (for boys with a probability of 90.2 %, for girls – 92.1 %). The percentage ratio of these components has sexual peculiarities. Methodologies for assessing biological age for scientific purposes and rapid assessment for use in the practice of physical education and sports have been proposed. The indicators of rapid assessment are body length and the degree of hair development in the axilla. The reliability of the rapid assessment is 81.4 % for boys and 83.2 % for girls.

Conclusions: Developing adequate physical activities for adolescents of different biological ages will help improve the physical health of the younger generation.

KEY WORDS: adolescents, biological age, methodology, rapid assessment

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INTRODUCTION

One of the modern ways to improve high schoolers' physical health is to use a differentiated approach in physical education training sessions as an important condition for teaching and upbringing. It is important to implement this direction for adolescents because of significant individual differences in morphofunctional indicators in people of the same class and gender. This is especially true for 14-15-years old boys and 12-13-years old girls [1, 2].

It is established that adolescents' organism formation is characterized by heterochronism, extreme degrees of which are expressed either in acceleration of development or in slowing down against average values, characteristic for a given chronological age [1, 3]. Knowledge about heterochronicity helped identify the "biological age" as the formation of morphological structures and related functional manifestations of the organism's vital activity, characteristic of a given chronological age, achieved by an individual [2-4].

Many authors emphasize the significant differences between biological and chronological age [4, 5]. As of today, it has been proven, for example, that girls of the same chronological age differ in the pace of biological development. The difference in the rate of formation of secondary sexual characteristics can be 1-1.5 years [3, 5]. It has been established [4, 6] that among girls aged 12-13 years, 48% have a biological age that corresponds to the chronological age, 19% are ahead, and 33% are behind. The physical health assessment revealed that 38 % of girls aged 12-13 with low and below-average levels are female high schoolers whose biological age is ahead of their chronological age [4, 5, 7]. It is noted that the value of somatometric and physiometric indicators, circulatory and external respiratory functions features, cardiac performance, and blood distribution system in

large and small circles are more interdependent with adolescents' biological age than chronological age. The smallest dispersion of somatic parameters occurs in preschool age and reaches an average of one and a half years, and the largest – 3-4 years – is observed in adolescents [4, 8, 9].

The heterochronic nature of adolescents' biological development is also the reason for significant variability in the manifestation of their physical abilities indicators. Thus, in 12-13-years-old female high schoolers [3, 10] individual values of endurance, according to the results of 6-minute running at a distance, are in the range of 1060-1400 meters, the strength of hand muscles - in the range of 14-27 kg, strength endurance (lifting the torso from the supine position in 30 seconds) - 16-25 times, speed (according to the results of running 20 meters on the run) – in the range of 1.2-1.8 seconds, speed and strength capabilities (throwing a ball) - 290-380 cm. The given values have significantly substantial differences. The same is observed in indicators of agility, where the intragroup variation of results is 7-20 % and is the largest at 12-13 years old [2, 6]. It has also been proved that different values of total body size significantly influence the manifestation of physical abilities of adolescents [8, 11]. Thus, among 12-15-years-old high schoolers almost 75 % of variations of speed and strength abilities are caused by indicators of body weight and length as well as age, and the partial contribution of the latter does not exceed 25 % [1, 5, 12]. Thus, according to scientists, high schoolers of the same grade and sex are not a homogeneous group in terms of morphological and functional state, since the age-related process of growth and development of the high schoolers' organism is characterized by significant individual differences, most of all in adolescents. Among the reasons for the differences may be heredity (different rates of biological development of the body) and the influence of environmental conditions (different motor activity).

Studying the differences between the chronological and biological ages of high schoolers is important not only from a theoretical point of view but also for working out adequate developmental and health-improving activities in the process of physical education. Currently, this problem is still in its infancy. The main obstacle to its solution is a large number of proposals for assessing the biological age of high schoolers: 9 methodologies for boys and 14 for girls [13, 14, 15, 16]. The indicators and their combinations, as well as approaches and methods, are offered in different ways. To find out which of them should be preferred to work out developmental and health-improving physical education training sessions based on the chosen one, the interaction of the above proposals was studied separately for adolescent girls and boys.

AIM

The aim of this article is to substantiate the methodology for assessing the biological age of adolescent high schoolers (boys and girls).

MATERIALS AND METHODS

The research involved boys aged 14-15 (n = 102) and girls aged 12-13 (n = 101). The choice of these age groups is explained by the presence of the most significant individual differences in morphological and functional characteristics in these adolescents.

Methods: theoretical – analysis and generalization of literary sources, systematization, comparison of different views on the problem under research; empirical – anthropometry, somatometry, somatoscopy, tonometry, spirometry, dynamometry, Stange's test, Rufier, Robinson indices; data processing methods – sampling method, correlation and factor analysis.

To assess the biological age of adolescents, the following indicators were proposed: absolute and relative values of total body size, degree of maturity of secondary sexual characteristics, type of physical development, puberty rate, physical condition, type of somatic status, physical development index, annual growth of body length, degree of sexual maturity, age standards of lung capacity and muscle strength, somatotype, the index of heterochronicity, and comprehensive assessment of physical development. The interaction of the results of these indicators was determined using factor analysis. The task of factor analysis was the transition from numerical indicators of a certain system to a relatively small number of hidden factors [5]. After statistical processing, three representative indicators were identified: the level of physical development, the index of heterochronicity of growth and development, and the degree of manifestation of secondary sexual characteristics. The level of physical development was assessed by the ratio of the main body dimensions (body weight, body length, and chest circumference). The Index of Heterochronicity (IH) was calculated using the formula: $IH = ((I - p) \cdot I) / ((L - P) \cdot L) \cdot (T / t) \cdot 100$, where: L – body length, cm; P – body weight, kg; T – chest circumference, cm; l, p, t - relevant individual indicators.

The degree of manifestation of secondary sexual characteristics was assessed by the indicators of axilla and pubic hair, mammary gland development, and menstruation in girls (on a 3-point scale) [1, 6].

The procedure for organizing the research was previously agreed with the Committee on compliance with Academic Integrity and Ethics of the Ukrainian State Dragomanov University. This research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research

| Level of physical development | Index of Heterochronicity | | | |
|-------------------------------|---|---|---|--|
| | 94 and less | 95-110 | 111 and more | |
| Below-average, low | Р | С | А | |
| Average | С | С | C | |
| High, above-average | Р | С | А | |
| Gender formula | A ₀ P ₀ , A ₀ P ₁ , A ₁ P ₀ | A ₁₋₂ P ₂ , A ₂ P ₁₋₂ , A ₁ P ₁ | A ₂₋₃ P ₃ , A ₂ P ₂₋₃ | |

Table 1. Scheme for assessing the biological age of adolescent boys, recommended for use for scientific purposes

Note: C – biological age corresponding to chronological age; A – accelerator; P – retardant; A_{0-3} – degree of hairiness in the axilla; P_{0-3} – degree of hairiness on the pubis.

Table 2. Scheme for rapid assessment of the biological age of adolescent boys, recommended for use in the process of physical education

| De de les sth | Level of hair development in the axilla | | |
|--|---|---|---|
| Body length | 0-1 | 2 | 3 |
| Low, below-average from (X - 0.68 σ and less) | Р | Р | С |
| Average (X \pm 0.67 σ) | С | С | С |
| Above-average, high (X + 0.68 σ and more) | С | А | А |

Note: C - biological age corresponding to chronological age; A - accelerator; P - retardant.

Table 3. Scheme for assessing the biological age of 12-13-years-old girls, recommended for use for scientific purposes

| Level of physical development | Index of Heterochronicity | | | |
|-------------------------------|---------------------------|--|-----------------------------|--|
| | 94 and less | 95 – 100 | 111 and more | |
| Low, below-average | Р | С | А | |
| Average | С | С | С | |
| Above-average, high | Р | С | А | |
| Gender formula | $A_o P_o A_o P_i A_i P_o$ | $A_{1-2}P_{2'}A_{2}P_{1-2'}A_{1}P_{1}$ | $A_{2-3}P_{3'}A_{3}P_{2-3}$ | |

Note: C – biological age corresponding to chronological age; A – accelerator; P – retardant; A_{0-3} – degree of hairiness in the axilla; P_{0-3} – degree of hairiness on the pubis.

Table 4. Scheme for rapid assessment of the biological age of 12-13-years-old girls

| Dadularash | Degree of hair development | | |
|--|----------------------------|---|---|
| Body length | 0 – 1 | 2 | 3 |
| Low, below-average from (X - 0.68 σ and less) | Р | Р | С |
| Average (X \pm 0.67 σ) | С | С | С |
| Above-average, high (X + 0.68 σ and more) | С | А | А |

Note: C - biological age corresponding to chronological age; A - accelerator; P - retardant.

involving human subjects. Prior consent to participate in the research was obtained from all the participants.

RESULTS

SUBSTANTIATION OF THE METHODOLOGY FOR ASSESSING THE BIOLOGICAL AGE OF ADOLESCENT BOYS

As a result of factorization of the matrix of intercorrelations of nine complex indicators for assessing the biological age of boys, three significant independent factors were identified: the level of physical development, the index of heterochronicity of growth and development, and the degree of manifestation of secondary sexual characteristics. The total contribution of these factors to the generalized variance of the sample was 90.2 %. The contribution of the first factor (the level of physical development), the main features of which are the value of total body size, physiometric indicators, and components of body weight, amounted to 58.5 % of the total variance of the sample. The contribution of the second factor (the index of heterochronicity of growth and development) to the generalized variance of the sample was 18.9 %, and the contribution of the third factor (the degree of manifestation of secondary sexual characteristics) was 12.8 %. The contribution of the remaining factors to the generalized variance of biological age estimation was statistically insignificant (less than 5 %).

Based on the results of factor analysis the scheme of complex determination of adolescent boys' biological

age was developed, recommended for use for scientific purposes (Table 1), and its rapid assessment – for application in the practice of physical training (Table 2).

SUBSTANTIATION OF THE METHODOLOGY FOR ASSESSING THE BIOLOGICAL AGE OF ADOLESCENT GIRLS

Unlike boys, 14 methodologies are proposed in the literature to assess adolescent girls' biological age, not 9. Therefore, in the case of female high schoolers, there is also a problem of finding the most informative methodology. To this end, we studied the relationship between the methodologies on one sample (101 girls aged 12-13) using factor analysis. The first factor - the level of physical development (proportion of 43.5 %) characterizes the values of total body size and physiometric indicators. The second factor - the index of heterochronicity of growth and development - is associated with indicators of somatic body type (contribution to the generalized variance - 26.3 %). The third factor is the degree of manifestation of secondary sexual characteristics (contribution - 22.3 %). The contribution of other factors to the generalized variance of biological age assessment was statistically insignificant (7.9%). The proportion of each factor was determined by factor analysis, namely, the sum of the squares of the correlation coefficients was divided by the total number of biological age estimation methodologies (by 14). The total contribution of these factors to the total variance of the sample of adolescent girls was 92.1 %. In total, these indicators in girls determine biological age more reliably (by 1.9%) than in boys, and the proportion of each of them has specific differences.

Based on these indicators, the methodology for assessing the biological age of adolescent girls aged 12-13 years was developed, recommended for use for scientific purposes (Table 3), and a rapid assessment for use in physical education practice (Table 4). If two out of three indicators (the level of physical development, the index of heterochronicity, and gender formula) correspond to middle-aged values, then biological age corresponds to chronological age. If two of the three fall within the range of low or high values, they respectively characterize slowed or accelerated rates of biological development (retardant or accelerator)

To determine the biological age of adolescent girls at school, a rapid assessment is proposed, which allows teachers and high schoolers to quickly determine the pace of biological development: slow (P), medium (C), and accelerated (A) relative to the chronological age of female high schoolers.

The rapid assessment includes two indicators: body

length and the degree of development of axilla hair. The body length score (low, below-average, average, above-average, high) is determined by regional standards for assessing high schoolers' physical development.

The assessment of the degree of development of hair in the axilla is determined by a three-point system, namely: 0 – no hair, 1 – separate hairs, 2 – the presence of hair in the form of a mustache, 3 – hair developed over the entire surface of the axilla. According to the factor analysis, the total efficiency of this methodology in determining the biological age of 12-13-years-old adolescent girls is 83.2 %.

DISCUSSION

For many decades, scientists from around the world [3, 4, 13, 17] have been studying the issue of assessing a person's biological age, but there are still no uniform criteria for determining it. There are also no uniform criteria for determining the biological age of high schoolers. The concept of "biological age" arose because of the general need to consolidate a large amount of data on individual characteristics of ontogenesis in periods corresponding to chronological age. That is why it pays tribute to the significant individual variety of organismal characteristics that are somehow related to the function of time, especially during periods of growth and development [4, 15]. Depending on the tests used, biological age can be assessed in the coordinates of any body system and at virtually all stages of ontogeny [16, 17]. Foreign scientists have made a significant contribution to the development of determining the biological age of children and adolescents [13, 14, 16, 18, 19]. The authors of [16] based their methodology on a scoring system for the manifestation of each of the proposed signs of biological development of the subjects. Geneticists at Morgantown University (West Virginia) have proposed a fundamentally new methodology for determining a person's biological age. For this purpose, only one indicator is measured. The methodology is as follows: using a blunt spatula, a sample of mucosal cells is taken from the inner surface of the cheek. Scientists believe that changes in the energy state of cells correspond to age-related changes in the body as a whole [19-21]. It is still an open question how convenient this methodology is. After all, it requires special equipment and the professionalism of researchers. It is unlikely to be widely used as a rapid methodology by teachers of secondary schools.

The analysis of modern sources on this issue shows that morphological [17], functional [18], and complex [19, 22] criteria are proposed to determine the biological age of adolescents. Determining the most valid among them is of great theoretical and practical importance in modern conditions.

CONCLUSIONS

- 1. As a result of factorization of the matrix of intercorrelations of nine complex indicators of biological age assessment of 14-15-years-old boys, three significant independent factors were identified: the level of physical development (58.5 % of the total variance of the sample), the index of heterochronicity of growth and development (with a proportion of 18.9 %) and the degree of manifestation of secondary sexual characteristics (with a proportion of 12.8 %). The total contribution of these factors to the generalized variance of the sample was 90.2 %.
- 2. Unlike boys, fourteen methodologies were proposed to assess the biological age of adolescent girls, not nine. The biological age of adolescent girls can also be reliably (with a probability of 92.1 %) determined using three indicators: the level of physical development, the index of heterochronicity of growth and development, and the degree of manifestation of secondary sexual characteristics with a proportion of 43.5 %, 26.3 %, and 22.3 %, respectively.
- 3. Based on these indicators, methodologies for assessing the biological age of boys and girls in primary school have been developed, which are recommended for use both for scientific purposes and for rapid assessment for use in physical education practice.

Prospects for further research include the development of differentiated physical activity during physical education training sessions for primary school-aged children.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Valery G. Arefiev

Ukrainian State Dragomanov University 9 Pirogova St, 02000 Kyiv, Ukraine e-mail: sport_2021@ukr.net

ORCID AND CONTRIBUTIONSHIP

Valery G. Arefiev: 0000-0002-1531-3523 (A) Olena V. Andrieieva: 0000-0002-2893-1224 (B) (D) Oleksandr A. Arkhipov: 0000-0002-8439-5833 (C) Nataliia D. Mykhailova: 0000-0003-0797-5137 (B) Inna M. Liakhova: 0000-0001-6882-7299 (D) Ivan M. Okhrimenko: 0000-0002-8813-5107 (E) Lyudmila V. Moroz: 0000-0001-6087-1252 (E)

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ORIGINAL ARTICLE

CONTENTS 🔼

Maintaining a healthy lifestyle by service members under martial law

Grygoriy P. Griban¹, Olha S. Zablotska², Natalia A. Lyakhova³, Iryna I. Shpak⁴, Soslan G. Adyrkhaiev⁵, Lyudmyla V. Adyrkhaieva⁵, Pavlo P. Tkachenko⁶

¹ZHYTOMYR IVAN FRANKO STATE UNIVERSITY, ZHYTOMYR, UKRAINE ²ZHYTOMYR MEDICAL INSTITUTE OF ZHYTOMYR REGIONAL COUNCIL, ZHYTOMYR, UKRAINE ³POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE ⁴KYIV MEDICAL UNIVERSITY, KYIV, UKRAINE ⁵OPEN INTERNATIONAL UNIVERSITY OF HUMAN DEVELOPMENT "UKRAINE", KYIV, UKRAINE ⁶POLISSIA NATIONAL UNIVERSITY, ZHYTOMYR, UKRAINE

ABSTRACT

Aim: To study the peculiarities of maintaining a healthy lifestyle by service members under martial law.

Materials and Methods: The research was conducted in 2022-2024 and involved 60 service members aged 22 to 54. According to their military rank, the respondents were divided into the following groups: junior enlisted (51.7 %), non-commissioned officers (25 %) and commissioned officers (23.3 %). Methods: bibliographic, system analysis and generalization, medical and sociological (questionnaire survey), and statistical.

Results: It was found that a healthy lifestyle for most service members is associated with motor activities (51.7 %), rational nutrition (55.9 %), the ability to cope with stress (42.4 %), and giving up bad habits (37.3 %). Only 46.7 % of service members adhere to the relevant principles, even though 55.0 % of respondents named a HLS as one of the values in their unit. It was found that it is difficult to fully adhere to the principles of a healthy lifestyle under the conditions of war. 76.7 % of service members have bad habits (the most common is smoking – 72.2 %).

Conclusions: Promising means of forming a healthy lifestyle for service members are: positive motivation and personal conviction in the need to maintain a healthy lifestyle, high-quality medical care, conducting educational work with personnel about the benefits of leading a healthy lifestyle, etc. However, these measures will become fully effective only if we end the war with victory and liberate all Ukrainian lands from the occupying forces.

KEY WORDS: health, healthy lifestyle, service members

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INTRODUCTION

At all times, the observance of a healthy lifestyle (HLS) by service members and, as a result, the preservation and promotion of their health, has been and remains a task of the state level [1-3]. After all, only mentally and physically healthy service members are combat-ready and able to fully defend the country from invaders.

The full-scale war, which has already been going on for two years, has made and continues to make adjustments to the lifestyle of every Ukrainian, especially to the service members of the Armed Forces of Ukraine. In the process of performing their professional duties in wartime, the possibilities of observing the principles of a HLS are significantly limited, which leads to a deterioration in the psychological state of personnel, exacerbation of chronic diseases, and the initiation or return to bad habits – smoking, alcohol consumption, and other stimulants and psychotropic drugs [4, 5]. The key to preserving the physical and mental health of service members under martial law is their adherence to the principles of a HLS [6, 7]. However, this issue is not sufficiently disclosed in scientific theory, which led to the choice of the research topic.

AIM

The aim is to study the peculiarities of maintaining a healthy lifestyle by service members under martial law.

MATERIALS AND METHODS

The research was conducted in 2022-2024 at Zhytomyr Medical Institute of Zhytomyr Regional Council and Zhytomyr Ivan Franko State University. The research involved 60 service members (88.3 % men and 11.7 % women) aged 22 to 54 from different regions of Ukraine. According to their military rank, the respondents were divided into the following groups: junior enlisted (51.7 %), non-commissioned officers (25 %), and commissioned officers (23.3 %) from different branches of the Armed Forces of Ukraine.

Scientific methods: bibliographic, system analysis and generalization, medical and sociological, statistical. The bibliographic method included an analytical review of sources of scientific information on the research topic (19 sources from the scientometric databases Index Copernicus, Scopus, PubMed, and others were investigated). The method of system analysis and generalization was used to formulate conclusions based on the results of the research; medical and sociological – for questioning service members; statistical processing method - for processing the experimental data obtained in the course of the research. The questionnaire survey was anonymous and contained 41 questions aimed at studying the level of awareness of the service members of the Armed Forces of Ukraine about the essence of the principles of a HLS; studying the state of involvement of service members in a HLS; identifying the degree of coverage of service members with a HLS; assessing the impact of a HLS on the health and combat readiness of service members; identifying promising areas for preventing morbidity among service members through their adherence to a HLS. The results were used for scientific purposes only. The questionnaire survey was evaluated by the experts in this field (3 professors and 5 associate professors) and was approved by the Academic Council of Zhytomyr Ivan Franko State University (Protocol No. 2 dated 30.09.2022). Consent to voluntary participation in the survey was obtained from all the respondents involved in the research. This research followed the regulations of the World Medical Association Declaration of Helsinki.

RESULTS

The interpretation of the concept of a "healthy lifestyle" is determined by each service member personally, but the majority of respondents (51.7 %) tend to believe that it is an active lifestyle; 40 % of service members associate a HLS with rational nutrition, 41.7 % – with improving physical development, 38.3 % – with hardening, 33.3 % – with disease prevention. At the same time, our research did not reveal any dependence of the answers on age, gender, or type of military service.

As for the awareness of service members about the principles of a HLS, the answers of the respondents are presented in Fig. 1. As can be seen, despite the

mentioned rational nutrition (55.9%), active recreation, exercises, and sports (61.0%), 39% of respondents indicated a positive attitude to life and 42.4% – the ability to cope with stress.

The main sources of information on a HLS defined by the service members were the media (62.1 % of respondents), medical professionals (25.9 %), and colleagues (12.1 %). However, only 46.7 % of service members reported personal adherence to the principles of a HLS (Fig. 2).

According to the research results, only 6.8 % of respondents believe that their attitude toward a HLS is not supported in the unit and is not one of the core values. At the same time, 55 % of respondents reported that a HLS is still one of the values in their unit. In general, the attitude of 60 % of respondents to a HLS has changed since the beginning of the full-scale invasion of Ukraine by the russian aggressor on February 24, 2022. Unfortunately, 40 % of service members began to pay less attention to maintaining a HLS. However, 53.4 % of respondents noted that the need to complete a combat mission contributes to the observance of a HLS. At the same time, 56.7 % of respondents believe that maintaining a HLS requires additional material costs.

The research also revealed the main strategies for overcoming the difficulties associated with restrictions on the need to maintain a HLS. The priority strategies are the use of hygiene products (60 %) and wet wipes (52.7 %), as well as compliance with the principles of occupational and rest hygiene (43.6 %).

The questionnaire survey also revealed that 25 % of respondents, regardless of age, gender, military rank, or type of military service, do not follow the rules of rational nutrition. However, 54.2 % of respondents indicated that the main ways to replenish their bodies were through a healthy diet and the consumption of fruits and vegetables. Only 16.7 % of service members do not have the opportunity to consume enough fluids. Every day, 18.6 % of respondents exercise, and 45.8 % exercise several times a week. The rest of the respondents rarely exercise for various reasons. Since the beginning of the full-scale invasion, 57.6 % of respondents have reduced the frequency of exercise and sports. Service members maintain their physical fitness in various ways, including exercising without being tied to exercise equipment, running, bodyweight exercises, morning warm-ups, military training, etc. A total of 26.7 % of respondents reported not being able to maintain good sleep hygiene. Unfortunately, 40.0 % of service members reported poor sleep quality due to frequent waking up; 11.7 % of respondents have problems falling asleep; 20 % of service members do not have regular sleep or have nightmares.


Fig. 1. Awareness of the principles of a HLS among service members (n = 60, %).

Fig. 2. Distribution of respondents by adherence to the principles of a HLS (n = 60, %).

Fig. 3. Bad habits of service members (n = 60, %).

The questionnaire survey found that 50.8 % of service members seek medical care only when ill. Also, 13.6 % of respondents believe that monitoring their health by undergoing preventive medical examinations is a waste of time.

It was found that 76.7 % of service members have bad habits. The most common bad habit among service members is tobacco smoking (72.2 %) (Fig. 3).

It should be noted that during the war, neither the emergence of new nor the disappearance of old bad habits among the surveyed service members almost did not occur. Among the new bad habits, respondents mentioned smoking and swearing. However, among the habits that the military got rid of was also tobacco smoking. It was found that only 6.7 % of service members believe that there is no connection between a person's well-being and adherence to a healthy lifestyle. 79.6 % of service members deny that they have chronic diseases due to non-compliance with HLS rules. At the same time, only 5.1 % of service members believe that a positive attitude to life and the socio-psychological climate have no impact on their overall well-being.

Especially in times of war, the ability of service members to control the impact of stress on the body is of great importance. It was found that 82.4 % of respondents can control the impact of stress in full and partially.

Among the changes that, according to respondents, should be introduced into the organization of daily, training and combat activities to promote a HLS among more service members are the following: positive motivation to maintain a HLS; compliance with the requirements of the daily routine, social guarantees for service members; high-quality medical care; conducting educational work with personnel about the benefits of maintaining a HLS; service time for sports and availability of means of versatile physical activities; victory over the enemy and the end of the war. According to servicewomen, the most effective options for improving their HLS are the following: a personal conviction in the need to maintain a HLS; encouragement to maintain a HLS; cooking with fresh meat, prohibiting the use of canned stewed meat in canteens, leaving it only in dry rations; proper nutrition; preventive medical examination; vitamin intake; compliance with the rules of work and rest, especially within the unit; motivation to get rid of bad habits; bringing the statutory requirements to the realities of today; conducting a campaign to take care of mental health; promoting continuous improvement of intellectual development; observance of social guarantees; ending the war with our victory, destruction, and elimination of all enemy armed forces on the territory of Ukraine; complete liberation of all territories from occupation forces.

DISCUSSION

According to the World Health Organization, individual "health" is a state of complete physical, spiritual (mental), and social well-being considered at the societal (population), group, and individual levels [8]. Physical health is determined by the state of functioning of the body when a person can perform all his or her duties (e.g., studying or household chores) without excessive fatigue; spiritual (mental) health is determined by the level of satisfaction with oneself, which arises as a result of the realization of capabilities and the ability to withstand stress; social health is determined by the level of establishing and maintaining contacts with other people [9, 10].

The formation of human health is influenced by external and internal factors, including external factors such as health care structure; ecology; climatic and geographical zones; financial status; economic situation of the country, war, etc.; internal factors such as genetic changes; hereditary diseases; lifestyle and the presence or absence of certain habits [11]. Experts [12] advise to actively and gradually form a good habit, and adhere to a HLS, which involves sufficient physical activities, satisfaction of material and spiritual needs, information competence, social proactive attitude and obtaining a certain professional and social status, etc. Scientists [13, 14] identify the following as the main negative factors affecting human health: psycho-emotional overload; insufficient physical activities; irrational diet; and bad habits (smoking, excessive alcohol consumption, substance abuse, various types of addictions).

By organizing their lives and choosing to lead them in a HLS, each person has the choice to promote their health or ignore it, guided by the following: personal responsibility for their own life, a high level of self-respect, the belief that healthy behavior helps to create a quality life and the availability of skills that contribute to this [15]. However, the war in Ukraine, as a social phenomenon, poses a serious threat to the principles of a HLS. Because of the war, Ukrainians are experiencing great stress and fear for themselves and their loved ones, which significantly worsens their health.

A HLS and strict adherence to safety measures are important components of the successful performance of military duty by each service member. The procedure for organizing a system of measures aimed at promoting health, preventing diseases, and comprehensive physical development of our country's service members is regulated by the Laws of Ukraine, the Statutes of the Armed Forces of Ukraine, orders, instructions, and other regulatory documents. According to the recommendations of the COSC (Combat Operation Stress Control) unit, representatives of the NATO army, the main components that affect the combat capability of each soldier are the so-called "survival triad": sleep, activity, and nutrition [16]. Given that no country in the world has had the same experience in combat operations over the past 70 years as Ukraine, we believe it is appropriate to add "personal hygiene" and "emotional and motivational component" to this triad. Staying in a combat zone involves partial or complete lack of sleep, and is accompanied by irrational nutrition, and physical and mental overload, which leads to many disorders of the service member's body. In addition, the war significantly reduces access to basic needs, such as water, heat, food, and hygiene products [17]. In combat situations, service members face stressful and traumatic situations every minute, experiencing various emotions, usually keeping them to themselves and not discussing them with anyone. This results in many negative conditions, such as depression, psycho-emotional burnout, loss of meaning and apathy, and even suicidal crisis [18]. At the same time, according to scientists [19], the issue of maintaining a HLS and preventing various diseases is of utmost importance. According to the results of numerous studies, spending money on the early detection of possible diseases and their timely prevention reduces the financial burden of treating service members and veterans in the future.

CONCLUSIONS

The overwhelming majority of the surveyed service members associate a HLS with motor activities (51.7%) and improved mental and physical health (41.7%). In addition to the principles of a HLS mentioned above, the respondents also declared rational nutrition (55.9%), the ability to cope with stress (42.4%), and the rejection of bad habits (37.3%). Under martial law, 40.0% of the respondents began to pay less attention to a HLS. Only 46.7% of service members adhere to the

relevant principles, even though 55.0 % of the respondents named a HLS as one of the values in their unit and noted its connection with the successful completion of combat missions.

It was found that it is difficult to fully adhere to the principles of a HLS in war. 76.7 % of service members have bad habits. The most common bad habit among service members is tobacco smoking (72.2 %). However, despite the wartime restrictions, a certain number of service members maintain their physical fitness in all available ways. An optimistic attitude to life and the creation of a positive social and psychological climate in military units contribute to motivation to maintain a healthy lifestyle.

According to the respondents, the following are promising means of forming a HLS of service members: positive motivation and personal conviction in the need to observe a HLS, high-quality medical care, conducting educational work with personnel about the benefits of maintaining a HLS, etc. However, these means will become fully effective only if we end the war with victory, eliminate all enemy armed forces on the territory of Ukraine, and completely liberate all Ukrainian lands from occupation forces.

Prospects for further research are aimed at finding new approaches to engaging the majority of service members in a HLS.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Grygoriy P. Griban

Zhytomyr Ivan Franko State University 40 Velyka Berdychivska St, 10008 Zhytomyr, Ukraine e-mail: gribang@ukr.net

ORCID AND CONTRIBUTIONSHIP

Grygoriy P. Griban: 0000-0002-9049-1485 Olha S. Zablotska: 0000-0002-0850-5754 Natalia A. Lyakhova: 0000-0003-0503-9935 Iryna I. Shpak: 0009-0008-2304-7756 Soslan G. Adyrkhaiev: 0000-0001-7083-8499 Lyudmyla V. Adyrkhaieva: 0000-0002-1102-170X Pavlo P. Tkachenko: 0000-0003-4407-8611 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

Teachers' assessment of the mental health of children with special educational needs during the war

Kateryna S. Dovhopola¹, Olha O. Nabochenko², Tetiana M. Kostenko³

¹ MYKOLA YARMACHENKO INSTITUTE OF SPECIAL PEDAGOGY AND PSYCHOLOGY OF THE NATIONAL ACADEMY OF EDUCATIONAL SCIENCES OF UKRAINE, KYIV, UKRAINE

² PUBLIC ORGANIZATION "SUPPORT THE CHILD", KYIV, UKRAINE

³ ASSOCIATION OF EFFECTIVE PSYCHOLOGISTS OF UKRAINE, KYIV, UKRAINE

ABSTRACT

Aim: To study the results of teachers' assessment of the mental health of high schoolers with special educational needs (SEN) after the 1.5 years of war in Ukraine. **Materials and Methods:** Teachers' assessment of the mental health of high schoolers with SEN was conducted through an anonymous survey of teachers using the questionnaire developed by the authors. The research, conducted in 2023, involved 739 teachers working with high schoolers (ages 6-10) with SEN. **Results:** It was found that 32.3 % of high schoolers were in the combat zone or on the temporarily occupied territory; 31.7 % of high schoolers were forced to leave their homes and were temporarily displaced, 17.7 % went through a separation from their parents, 15.8 % witnessed hostilities, and 3.8 % suffered bullying from their peers. In the educational process, high schoolers with SEN most often experienced anxiety (55.2 %), "emotional swings" (48.4 %), restlessness (44.8 %), fear (37.2 %). During the 1.5 years of war, 15.4 % of high schoolers began to study worse, 12.9 % began to spend more time playing computer games and on social media. It was found that 59.9 % of teachers need more information on maintaining the mental health of high schoolers with SEN. **Conclusions:** The results obtained proved the negative impact of hostilities on the territory of Ukraine on the mental health of high schoolers with SEN, which

necessitates the provision of adequate psychological support by teachers of such high schoolers in the educational process.

KEY WORDS: mental health, children with special educational needs, teachers, psychological assistance, war in Ukraine

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INTRODUCTION

According to WHO [1], approximately one in five people in post-conflict situations suffer from depression, anxiety disorder, post-traumatic stress disorder (PTSD), bipolar disorder, or schizophrenia. Ukrainians affected by the war since 2014 have the highest rates of these disorders: PTSD (32 %), depression (22 %), anxiety (17 %), etc. [2, 3]. According to the experts [4], about 15 million Ukrainians will need psychological support because of the war.

According to the research [5], about 5.7 million children remain inside the country under the threat of physical and emotional harm as a result of the ongoing hostilities in eastern and southern Ukraine and the constant threat of air strikes and shelling throughout the country. All these factors increase the risks for children to suffer emotional harm and mental health problems, including depression and post-traumatic stress disorder, which leads to emotional and physical symptoms, as well as risks and obstacles to children's development. More than half of all adult mental disorders begin before the age of 14, and three-quarters before the age of 18 [6]. The most vulnerable category is children with special educational needs (SEN) [7, 8].

Children with SEN perceive crises differently from children with normal development and are much more vulnerable to negative consequences due to their psychophysiological characteristics [9]. The reaction of a child with SEN to a traumatic event depends on several factors: developmental features, the nature of special educational needs, age, experience, the severity and proximity of the traumatic event to the child, as well as the level of support received from significant adults, specifically family members, and teachers. At the same time, children with SEN need psychological assistance that takes into account the peculiarities of their condition and the nature of their special educational needs [10, 11]. The authors of the article partially addressed this issue in 2022 when studying the condition of children in the acute phase of traumatic stress caused by the full-scale war in Ukraine [12]. However, there has been no research on the impact of a full-scale

high-intensity war with a high component of secondary trauma on children with SEN, and no scientifically proven technologies for working with children with psychological trauma as a result of the war against the background of special educational needs or their emergence against the background of such trauma, no research on the long-term results of psychological assistance and support by teachers of children with SEN in the educational process.

AIM

The aim is to study the results of teachers' assessment of the mental health of high schoolers with SEN after the 1.5 years of full-scale war in Ukraine.

MATERIALS AND METHODS

Teachers' assessment of the mental health of high schoolers with special educational needs was conducted through an anonymous survey of teachers using the questionnaire developed by the authors. The research, conducted in 2023 using a Google form, involved 739 teachers working with primary high schoolers (ages 6-10) with special educational needs.

Research methods: analysis and generalization of literary sources, questionnaire survey, statistical methods. 22 sources from the databases Scopus, PubMed, Web of Sciences Core Collections, Index Copernicus and others were investigated. The survey was conducted according to the author's questionnaire, which contains 23 guestions to determine the impact of hostilities across the territory of Ukraine on the mental health of children with SEN. The survey was conducted using the Google form created by the authors (https://docs.google.com/forms/d/1eKYY-1jKV30PGuVEXKBBHKINcUQHP41z7efdsv1CNDnQ/ edit?usp=sharing_eip_m&ts=6570b67e). The results of the research were presented in percentages and processed in Microsoft Excel for Windows 10. This research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects. Informed consent was received from all respondents who took part in this research.

RESULTS

According to the survey of teachers working with children with SEN during the war in Ukraine, it was found that most of their high schoolers (32.3 %) were in the combat zone or on the temporarily occupied territory. This requires teachers to take this factor into account

when working with such children to provide them with better psychological support. It has been found that the emotional state of both teachers and their high schoolers with SEN is most affected by the situation in the country (76.1 % and 40.3 %, respectively), the situation in the family (17.4 % and 51.0 %, respectively) and the situation at school, in the team, in the classroom (3.2 % and 4.3 %, respectively). At the same time, the situation in the country is a more important factor in shaping the emotional state of teachers (76.1 %) than for high schoolers with SEN, whose psychological well-being is most importantly influenced by the situation in their families (51.0 %).

By interviewing teachers, we also identified stressful events and situations (psycho-traumatic factors) that their high schoolers with SEN had to go through during the 1.5 years of war in Ukraine. Thus, since the beginning of the war, 31.7 % of high schoolers with SEN were forced to leave their homes and move to another region of Ukraine or be temporarily displaced abroad, 17.7 % experienced one or more separations from their parents under various circumstances, 15.8 % witnessed hostilities, 12.0 % witnessed family conflicts, 4.6 % lost friends, 4.4 % experienced injury, illness or suffering of a close relative, 3.8 % of children were bullied by peers or other high schoolers one or more times, 2.9 % of children lost their homes (house or apartment), 2.4 % lost pets, 0.6 % were victims of physical violence. All of the above stressful events or situations have a greater or lesser impact on the mental health of children, especially those with SEN, which requires teachers or pedagogical staff working with such children to obligatorily take these factors (their severity, as well as the age and individual psychophysiological characteristics of high schoolers with SEN) into account to create a healthy climate in the student body, ensure the psychological well-being of such high schoolers in the educational process, provide them with personal psychological support and engage them in the educational process.

Assessing the psycho-emotional state of high schoolers with SEN in the educational process, we found that, according to teachers, some high schoolers are usually in a vigorous (38.4%) and cheerful (23.4%) state; some high schoolers (7.7%) were withdrawn; however, most often almost half of the high schoolers (49.9%) were in an unstable psycho-emotional state (the state of "emotional swings") (Fig. 1).

This is because the emotional and volitional sphere of primary high schoolers with SEN actively responds to emotional outbursts and situations around them, primarily provoked by the need to leave the zone of personal comfort (hostilities, systematic announcement of air alert, change of residence, deviation from



38,8

39,5

39,0

44.5

It was also found that most of the time during the war in Ukraine, teachers working with high schoolers with SEN were in a neutral mood (44.5 %) or a state of "emotional swings" (39.5 %), and their high schoolers were also mostly in a neutral mood (39.0%), in a state of "emotional swings" (38.8 %), and in a good mood (33.5 %) (Fig. 2).

It is worth noting that emotional swings, as strong emotions, can change rapidly and are difficult to con-



Fig. 1. Psycho-emotional state of high schoolers with SEN, in which they were most often in an educational institution (no more than two answers were allowed, %).



(no more than two answers were allowed, %).

the usual daily routine, etc.). It was found that over the 1.5 years of war, teachers working with high schoolers with SEN most often experienced anxiety (68.5 %), "emotional swings" (44.1 %), restlessness (42.5 %), fear (35.6 %), emotional pain (24.3 %), panic (14.4 %), and despair (10.4%) among the negative emotions. Among the positive emotions, the most pronounced among teachers were hope (35.6 %), confidence in the future (12.3 %) and self-confidence (9.3 %) (Table 1). In the educational process, high schoolers with SEN most often experienced such negative emotions as anxiety (55.2 %), "emotional swings" (48.4 %), restlessness (44.8 %), fear (37.2 %), and sadness (21.0 %). Among the positive emotions of high schoolers with SEN, hope

"Emotional swings"

Mood

Fear

Grieving

Happy

Joyful

Depressed

Neutral

Good

Bad

0

2,1

2.6 0,5

> 2,9 4,9

0,8

1,8

9,6

10

High schoolers

14,2

0.8 1.42,5

| Feelings experienced by respondents | Teachers of high schoolers with SEN (734 answers) | High schoolers with SEN (723 answers) |
|-------------------------------------|--|--|
| Fear | 35.6 | 37.2 |
| Anxiety | 69.5 | 55.2 |
| Restlessness | 42.5 | 44.8 |
| Panic | 14.4 | 13.1 |
| Emotional pain | 24.8 | 5.8 |
| Grief | 4.0 | 1.2 |
| Joy | 2.7 | 8.0 |
| Норе | 35.6 | 19.5 |
| Self-confidence | 9.3 | 3.9 |
| Confidence in the future | 12.3 | 4.7 |
| Despair | 10.4 | 4.0 |
| Sadness | 11.6 | 21.0 |
| "Emotional swings" | 44.1 | 48.4 |

Table 1. The feelings most often experienced by teachers and their high schoolers with SEN during the 1.5 years of war in Ukraine (no more than 3 options were allowed, %)

trol. At the same time, sudden mood swings are protective manifestations of the individual's psyche in the face of prolonged critical stress or danger. Additional factors can also influence this situation: responsibilities (work, social, or family), individual characteristics of both teachers and high schoolers, ability to self-control, etc. It should be added that only 1.4 % of teachers and 2.5 % of high schoolers with SEN felt happy, 2.9 % of teachers and 9.6 % of high schoolers felt joyful; while 14.2 % of teachers and 4.9 % of high schoolers felt depressed. This is due to the impact of general social tension on teachers and high schoolers, which naturally affects all members of society and determines the dominance of depressed mood.

In addition, teachers note that some high schoolers with SEN became worse at school over the 1.5 years of war (15.4 %), started spending more time playing computer games and on social media (12.9 %), became withdrawn (7.9 %), tearful (6.7 %), indifferent (3.7 %), almost stopped communicating with peers and teachers (2.5 %), started behaving inappropriately (2.8 %), and began to commit risky acts (0.8 %). Such indicators are likely due to the emergence of compensatory mechanisms in children's psyches that become relevant in the face of rapid changes in the usual mode of life.

The results obtained indicate the presence of mental health problems in some high schoolers with SEN that require professional psychological assistance. At the same time, it is worth noting that according to the results of the survey, we found that more than 70 % of high schoolers with SEN worked with psychologists over the 1.5 years of war: constantly (52.8 %), occasionally (22.5 %). According to teachers, the most effective

ways to improve the mental health of high schoolers with SEN and provide them with psychological assistance are art therapy as a type of psychotherapy or psychological correction based on art and creativity (dance and movement therapy, music therapy, bibliotherapy, fine arts therapy) (66.2%), development of emotional resilience skills in stressful situations or during traumatic events (52.9 %), classes on developing high schoolers' memory, thinking, attention, perception (46.1 %), development of the speech sphere (30.7%), application of modern special teaching methods (16.4%). At the same time, 59.9 % of teachers working with high schoolers with SEN need more information on maintaining or correcting the mental health of high schoolers with SEN and providing psychological assistance to such high schoolers in the educational process. In addition, they want to receive such information in the form of video lessons (during seminars, webinars, etc.) (53.0%), short training (theoretical, methodological, and practical) classes via social media (46.2 %), consultations with subject matter specialists (42.9 %), specialized training courses (38.6 %), textbooks, articles, practical recommendations and other literary sources (25.1 %).

DISCUSSION

According to the survey conducted by the Sociological Group referred to as the "Rating" from January 27 to February 1, 2023 [13], 60 % of children witnessed or participated in some war-related events. Most often, according to mothers, children experienced the following traumatic events: separation from family and friends (28 %), relocation to another region of the country (25%), shelling and bombing (24%), and staying in a cold room for a long time (17%). 11% of children moved abroad, 8 % were under occupation, 6 % witnessed the death of relatives or friends, 5 % lost their homes, and 5 % experienced hunger and lack of water. At the same time, among the factors that can cause traumatic psychological states in children, mothers most often recorded fear of loud noises (especially for children under 9 years old). Also, irritability and apathy, indifference to learning, and past hobbies were recorded relatively more often (these manifestations are more common in children of middle and senior high school age). In addition, outbursts of anger and aggression are a relatively common problem (among all children). Such signs of anxiety as fear of the future, sleep problems, nightmares, memory, and concentration problems were more often recorded in older children (16-17 years old), and the reflection of traumatic events in games and creativity – among the youngest (3-9 years old) [13].

The studies conducted using the CRIES-8 questionnaire (Revised Child Impact of Events Scale) [14] revealed high scores on the "Avoidance" scale as a diagnostic criterion for disorders of the emotional and behavioral sphere of the studied children. According to the screening data, the actual form of children's experiences is the actualization of reactive experiences of a traumatic situation in the form of intrusion. The scientists [15] note the significant impact of trauma on children's condition and most often operate with such concepts as psychological trauma, acute stress, PTSD, maladjustment, grief (mourning, prolonged grief reaction), and traumatic loss. The author [16] notes that constant stress can lead to negative consequences, such as anxiety, depression, aggressiveness, sleep and concentration problems, decreased self-esteem, and other mental health problems.

In turn, the researchers [18] identified four domains of prognostic variables that can help identify children and adolescents at greatest risk of further problems: aspects of traumatic exposure (including perceived life threat, death of a loved one (especially if the death was violent and witnessed by a child), parental post-traumatic distress, loss of property and disruption of daily routines (especially moving from home, school and community), proximity to the event, physical trauma, as well as duration and intensity of life-threatening events), child's previous features, characteristics of the recovery environment and child's psychological resources. The studies have also noted that children with academic (learning) difficulties before traumatic events, poor academic performance, and attention span problems are at greater risk of posttraumatic problems [18]. The experts [19, 20] suggest that resilience to the

negative impact of posttraumatic experience may also be associated with average or higher intelligence, good communication skills, a strong belief in self-efficacy, internal locus of control, and adaptive coping skills, which are quite low in children with SEN, including children with intellectual disabilities. Our research confirms the conclusions of many scientists [2, 5, 7, 9, 11, 21, 22] and supplements and expands on them with the results of teachers' assessment of the mental health of children with SEN of primary school age (6-10 years old) after the 1.5 years of war in Ukraine, and confirms the need for teachers to provide psychological support and assistance to such high schoolers in the educational process.

CONCLUSIONS

The survey of teachers working with children with SEN during the war in Ukraine found that 32.3 % of their high schoolers were in the combat zone or on the temporarily occupied territory; 31.7 % of high schoolers were forced to leave their homes and relocate to another region of Ukraine or were temporarily displaced abroad; 17.7 % experienced one or more separations from their parents under various circumstances; 15.8 % witnessed hostilities; 12.0 % of children witnessed family conflicts, 4.6 % lost friends, 4.4 % experienced injury, illness or suffering of a close relative, 3.8 % of children were bullied by peers or other high schoolers once or several times, 2.9 % of children lost their homes (house or apartment), 2.4 % lost pets, 0.6 % became victims of physical violence. In the educational process, high schoolers with SEN most often experienced such negative emotions as anxiety (55.2%), "emotional swings" (48.4 %), restlessness (44.8 %), fear (37.2 %), sadness (21.0%); among positive emotions, hope (19.5%) and joy (8.0 %) dominated. High schoolers with SEN were mostly in a neutral mood (39.0 %), in a state of "emotional swings" (38.8%), and only 2.5% of high schoolers felt happy and 9.6 % joyful. In addition, during the 1.5 years of war, some high schoolers with SEN began to study worse (15.4%), began to spend more time playing computer games and on social networks (12.9%), and became withdrawn (7.9%). It was found that 59.9% of teachers working with high schoolers with SEN require more information on maintaining the mental health of high schoolers with SEN and providing psychological assistance to such high schoolers in the educational process.

It was found that high schoolers with SEN may experience manifestations of psychological trauma, the intensification of which may be associated with the child's age and type (category) of special educational needs (difficulties), severity and type of trauma (including staying in the temporarily occupied territories, staying in the war zone, forced displacement, additional stressful events, and situations (traumatic factors), including the loss of loved ones, injuries, loss of friends, relocation, etc.), the psychological state of family members (their emotional state and factors influencing it), the availability of professional psychological support or assistance, and teachers' awareness of psychological support for high schoolers in the educational process in war.

The results obtained proved the negative impact of hostilities on the territory of Ukraine on the mental health

of high schoolers with SEN, which necessitates the provision of adequate psychological support by teachers of such high schoolers in the educational process, as well as the involvement of psychologists in the restoration and maintenance of the mental health of such children.

PROSPECTS FOR FURTHER RESEARCH

It is planned to develop practical recommendations for teachers to provide psychological support to high schoolers with SEN.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Tetiana M. Kostenko

Association of Effective Psychologists of Ukraine 12 Kozhumyatska st., 04071. Kyiv, Ukraine e-mail: tanya_t.k@ukr.net

ORCID AND CONTRIBUTIONSHIP

Kateryna S. Dovhopola: 0000-0002-5306-4505 A D E Olha O. Nabochenko: 0000-0002-9347-3864 B C Tetiana M. Kostenko: 0000-0002-4976-1236 B D F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

Motivational and value-based attitude of law enforcement officers to motor activity as a factor of a healthy lifestyle

Ivan M. Okhrimenko¹, Olena Yu. Pop², Nataliia V. Hresa³, Alla A. Shylina³, Valentyna O. Tyurina³, Oleksandr V. Bakanychev⁴, Natalia A. Lyakhova⁵

¹NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE

²VINNYTSIA MYKHAILO KOTSIUBYNSKYI STATE PEDAGOGICAL UNIVERSITY, VINNYTSIA, UKRAINE

³ KHARKIV NATIONAL UNIVERSITY OF INTERNAL AFFAIRS, KHARKIV, UKRAINE

⁴STATE UNIVERSITY OF INFORMATION AND COMMUNICATION TECHNOLOGIES, KYIV, UKRAINE

⁵ POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE

ABSTRACT

Aim: To study the attitude of law enforcement officers to motor activity and investigate its impact on their health.

Materials and Methods: The research, which was conducted in 2022-2024, involved 163 law enforcement officers under the age of 30. Research methods: bibliosemantic, questionnaire, testing, medical and biological methods, methods of mathematical statistics.

Results: It has been found that the vast majority of law enforcement officers (85.3 %) understand the importance of motor activity as a factor of a healthy lifestyle, its impact on physical and mental health, and quality of their professional activities. At the same time, only 27.6 % of law enforcement officers systematically engage in motor activity, 52.8 % do it sporadically, and 25.8 % do not engage in it at all. Among the reasons that prevent them from exercising are lack of time (65.6 %), lack of desire (31.3 %), and fatigue after a service day (28.1 %). It has been found that law enforcement officers who systematically engage in motor activity have a significantly better level of health (7.31 points) compared to those who engage in occasional motor activity (5.07 points) and do not engage at all (2.19 points).

Conclusions: The positive impact of motor activity on the level of health of law enforcement officers has been proved. Good health is a guarantee of high resistance of law enforcement officers to negative factors of professional activities, professional longevity, and quality of their professional tasks.

KEY WORDS: health, healthy lifestyle, motor activity, law enforcement officers

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INTRODUCTION

Health is the most important of all human values. Good health and high resistance to adverse environmental factors is one of the important conditions for active longevity, successful learning, productive professional activities as well as personal and family happiness [1]. Health is defined as a human condition that is characterized not only by the absence of diseases or physical defects but also by complete physical, mental, and social well-being [2]. Therefore, only a physically, spiritually, and mentally healthy person can realize his or her potential in the most effective way and feel like a full-fledged member of society.

At the same time, one of the most important social problems of our time is the deterioration of public health. Under current conditions, Ukraine is facing a critical public health situation due to: the Covid-19 pandemic and other viruses that have led to a sharp increase in morbidity; the russian occupation of Ukrainian territories, and the high threat of constant rocket attacks on civilians, which has led to a critical deterioration in both physical and mental health of Ukrainians; the transition of most Ukrainian educational institutions to distance learning, which has led to a significant decrease in the motor activity of young people and the massive use of various gadgets; and other reasons [3]. As a result, the number of patients with functional disorders of cardiovascular, respiratory, musculoskeletal, visual, neuropsychiatric, and other diseases is increasing every year [4]. Unfortunately, law enforcement officers are no exception, whose health condition has deteriorated sharply in recent years due to the performance of special tasks of professional activities under martial law [5]. According to scientists [6], among the factors that affect health, more than 50 % are factors that characterize a person's lifestyle. That is, by forming and regulating a lifestyle, a person can influence his or her health. Scientists identify several key components of a healthy lifestyle, among which, along with a healthy diet, adequate sleep, and giving up bad habits, motor activity (exercise) plays an important role [7].

Motor activity is an integral part of a person's lifestyle and life-sustaining activities, which are determined by socio-economic and cultural factors, and also depend on the organization of physical education, morphological and functional characteristics of the body, type of nervous system, amount of free time, motivation to exercise, accessibility of sports facilities and recreation areas [8]. Motor activity is an important factor in maintaining high human working capacity. They have an impact on human biological nature forming the ability to self-manage, promoting health, stimulating the development of physical qualities, and improving mental performance [9].

A low level of motor activity negatively affects most functional systems of the body and is a factor in the emergence and development of a significant number of diseases. Scientists [10] note that insufficient motor activity can cause the following problems: respiratory distress during exercise, decreased working capacity, fatigue, sleep disturbances, reduced concentration, and increased nervous as well as emotional agitation. The scientific literature [11] also emphasizes that insufficient motor activity negatively affects the course of complex biochemical and physiological processes in the human body. This sharply reduces the function of the central nervous system, and fatigue sets in faster. Certain changes occur in the cardiovascular system. The activity of hormones decreases. For example, the content of adrenaline in the blood, a hormone that plays an important role in regulating the heart, is significantly reduced. There is also a decrease in noradrenaline in the heart muscle, which dramatically reduces its performance. There is a deterioration in the overall metabolism; sedentary people significantly increase their body weight, which in turn leads to other negative health consequences. The deterioration of health is even more pronounced in people with bad habits [13].

AIM

The aim is to study the attitude of law enforcement officers to motor activity and investigate its impact on their health.

MATERIALS AND METHODS

The research, which was conducted in 2022-2024, involved 163 law enforcement officers of National

Academy of Internal Affairs (NAIA) under the age of 30. Research methods: bibliosemantic, questionnaire, testing, medical and biological methods, methods of mathematical statistics. The bibliosemantic method was used to conduct an analytical review of scientific sources on the outlined range of issues (19 sources from PubMed, Scopus, Web of Science, Index Copernicus and other databases were analyzed). The questionnaire method involved surveying law enforcement officers using a questionnaire developed by the author's team. The questionnaire contains 10 questions, that are aimed at studying the motivational and value-based attitude of law enforcement officers to motor activity as a factor of a healthy lifestyle. The questionnaire was anonymous, which helped to increase the accuracy of the formulated conclusions. The questionnaire was assessed by the experts in this field (2 professors and 4 associate professors) and was approved by the Academic Council of NAIA (Protocol No. 2 dated 07.10.2022). Consent to voluntary participation in the survey was obtained from all respondents involved in the study. Medical and biological methods were used to study the impact of motor activity on the law enforcement officers' health level. Law enforcement officers' health level was examined according to the method of the professor H. L. Apanasenko [13] based on the anthropometry indicators (height, weight, lungs vital capacity, wrist dynamometry) and the state of the cardiovascular system (heart rate, arterial blood pressure). The health level was evaluated in points and it included the estimation of the body mass index, vital index, strength index, Robinson's index and heart rate recovery (HRR) time after a standard exercise. The method of system analysis and generalization was used to analyze the results obtained and formulate the conclusions of the research. The methods of mathematical statistics were applied to correctly process the data and identify the difference between the indicators under study. The compliance of the data distribution with the Gauss' law was assessed using the Shapiro-Wilk W-test. The authenticity of the difference between the indicators that were evaluated in points was determined by means of Student's test (t). The statistical significance for all statistical tests was set at p<0.05. All statistical analyses were performed with the SPSS software, version 21, adapted to medical and biological researches. This this research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects. Informed consent was received from all respondents who took part in this research.

RESULTS

As a result of the questionnaire survey, we found that most law enforcement officers have sufficiently substantive knowledge about the nature and components of a healthy lifestyle. Thus, 90.1 % of respondents explained the meaning of the concept through its components, 6.7 % gave a thorough definition of the concept of a "healthy lifestyle," and 3.2 % failed to cope with the task. The results show that, in general, almost all law enforcement officers surveyed understand the essence and importance of a healthy lifestyle. Studying the attitude of law enforcement officers to motor activity as one of the main factors of their healthy lifestyle, we found that 85.3 % of respondents are aware of their positive impact on physical and mental health, improved well-being, the quality of their professional activities and other components of their life-sustaining activities. 13.5 % of law enforcement officers assessed the role of motor activity in their personal and professional life as an important factor, but ranked it after nutrition and bad habits; 1.2 % of law enforcement officers, unfortunately, do not attach importance to this component of a healthy lifestyle.

It has also been found that the vast majority of respondents are convinced that motor activity has a positive impact on the physical health of law enforcement officers, improvement of physical development and functional capabilities of their body (96.3%); promotion of their mental health, emotional state, stress prevention and formation of mental resistance to factors of service activities (especially in martial law) (97.5 %); improvement of the quality of professional tasks performance within their service activities (regardless of specialty) (90.8%). At the same time, it was found that regular motor activity (systematic exercise) takes place in the lives of only 27.6 % of law enforcement officers (scheduled physical training sessions, independent classes); 52.8 % of respondents exercise occasionally (if they have free time, opportunity, and desire); 25.8 % of law enforcement officers do not exercise at all (over the past year).

The main motivational factors that encourage law enforcement officers to motor activity (to engage in physical exercise) include the following (no more than two answers were allowed): 41.9 % – health (physical and mental) promotion; 32.1 % – development of physical fitness; 30.5 % – improvement of appearance; 28.2 % – improvement of the quality of professional performance; 19.1 % – improvement of mood and well-being; 17.6 % –psycho-emotional relief; and 6.1 % – other factors. It was found that the main reasons that prevent law enforcement officers from engaging in motor activity include (no more than two answers were allowed): lack of free time – 65.6 %, lack of desire – 31.3 %, fatigue after a service day – 28.1 %; other reasons – 9.4 %. It should be added that among law enforcement officers who systematically engage in motor activity, 62.2 % were found to be satisfied with their health and physical fitness; among those who occasionally exercise, 47.7 % were found to be satisfied with their health; among those who do not exercise, only 21.9 % were satisfied with their health and physical fitness.

To study the impact of motor activity on the health of law enforcement officers, we assessed the level of physical health according to the methodology of Professor H. L. Apanasenko among law enforcement officers who are systematically engaged in motor activity (Group 1, n = 45), those who are engaged occasionally (Group 2, n = 86) and those who are not engaged at all (Group 3, n = 32). The results are presented in Table 1. It was found that law enforcement officers who systematically engage in motor activity have a significantly (p < 0.001) better health level compared to those who engage in occasional motor activity (by 2.24 points) and do not engage in motor activity at all (by 5.12 points). At the same time, law enforcement officers in Group 2 also have a significantly better health level than those in Group 3 (p < 0.001). At the same time, the health status of Group 1 corresponds to the average level, Group 2 – below average, and Group 3 – low.

These conclusions are confirmed by the ratio of law enforcement officers' physical health levels. Thus, in Group 1, the largest percentage of law enforcement officers have an average level (44.4 %), in Group 2 – below average (40.7 %), and in Group 3 – low (53.1 %). Moreover, in Groups 2 and 3, there were no law enforcement officers with high health levels, and the number of people with below-average and low health levels reached 74.4 % and 81.2 %.

DISCUSSION

According to scientists [14], implementing the principles of maintaining a healthy lifestyle is ensured by an optimal daily routine, healthy sleep, regular exercise, outdoor activities, hygienic computer use, minimizing the use of smartphones, regular preventive examinations, timely prevention of chronic diseases, etc. By organizing their lives and choosing to lead a healthy lifestyle, each person has the choice to improve their health or ignore it, guided by personal responsibility for their own life, a high level of self-respect, the belief that healthy behavior helps create a quality life, and the availability of skills that contribute to this [15].

Physical exercises are of great importance for health promotion and disease prevention, as they can en-

| | • | | | | | |
|--------------------------|--|-----------------|-----------------|--|--|--|
| Indicators under study | Group 1, n = 45 | Group 2, n = 86 | Group 3, n = 32 | | | |
| | Level of physical health, (M \pm m) points | | | | | |
| Level of physical health | 7.31 ± 0.26 | 5.07 ± 0.21 | 2.19 ± 0.31 | | | |
| p1-p2 | | < 0.001 | | | | |
| p2-p3 | | < 0.001 | | | | |
| p1-p3 | | < 0.001 | | | | |
| Ratio | of physical health levels, numbe | r of people / % | | | | |
| High | 3/6.7 | 0/0 | 0/0 | | | |
| Above average | 5/11.1 | 1 / 1.2 | 0 / 0 | | | |
| Average | 20 / 44.4 | 21 / 24.4 | 6 / 18.8 | | | |
| Below average | 10 / 22.2 | 35 / 40.7 | 9 / 28.1 | | | |
| Low | 7 / 15.6 | 29/33.7 | 17 / 53.1 | | | |

| Fable 1. The impact of mot | or activity on the level of | physical health of law en | forcement officers ($n = 163$) |
|-----------------------------------|-----------------------------|---------------------------|----------------------------------|
|-----------------------------------|-----------------------------|---------------------------|----------------------------------|

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of law enforcement officers; p1-p2, p1-p3, p2-p3 – significance of difference between the indicators of law enforcement officers' health level of Group 1 and Group 2, Group 2 and Group 3, Group 1 and Group 3 due to the t-test.

sure high human productivity and a whole range of recreational and rehabilitation activities [16]. Physical activities contribute to the functioning of the immune system, which prevents both infectious and non-infectious diseases. Motor activity is considered a nonspecific activator, a modulator of immunity. The first to respond to physical activity is peripheral blood cells – neutrophils, which are an important part of immune defense. The subsequent effect of physical training is explained by both direct and indirect (through hemostasis, nervous, cardiovascular, and endocrine systems) effects on general and local immunity. In addition, motor activity helps to reduce the level of catecholamines in the blood, while increasing the level of endorphin-like peptides, improving sleep, and digestion, thereby regulating the function of the immune system and preventing deterioration of health due to stress [17].

Because of the war, Ukrainians are experiencing great stress and fear for themselves and their loved ones, which significantly worsens their health. In these conditions, according to experts [18], it is important to maintain physical activities, which help to reduce the level of the stress hormone cortisol. In addition, scientists [19] advise Ukrainians who are in a safe place to resume exercise and sports, as regular physical activities have many benefits: prevention of stress and improvement of mood; strengthening of the cardiovascular and respiratory systems; normalization of cholesterol, blood glucose, and blood pressure; strengthening of muscles, bones and ligaments; reduction of the risk of injury, strengthening of the musculoskeletal system, development of strength, endurance, flexibility and agility; improvement of brain activity, increase of oxygen supply to the brain; improvement of creative abilities. The results of our research have confirmed

the findings of many scientists regarding the positive impact of motor activity on human health, including law enforcement officers.

CONCLUSIONS

The motivational and value-based attitude of law enforcement officers to motor activity as a factor of a healthy lifestyle has been studied. It has been found that more than 90 % of law enforcement officers have sufficiently substantive knowledge about the essence and components of a healthy lifestyle. The overwhelming majority of law enforcement officers (85.3%) understand the importance of motor activity as a factor of a healthy lifestyle, its impact on physical and mental health, improvement of well-being, and quality of their professional activities. At the same time, more than 95 % of respondents are convinced that motor activity has a positive impact on the physical and mental health of law enforcement officers, improvement of physical development and quality of performance of assigned tasks, and formation of mental resistance to negative factors of service activities. Therewith, only 27.6% of law enforcement officers systematically engage in motor activity, 52.8 % - sporadically, and 25.8 % - not at all. The main motivational factors that encourage law enforcement officers to engage in motor activity include the desire to improve their health (41.9 %); to increase their physical fitness (32.1 %); to improve their appearance (30.5%), etc. It was found that the main reasons that prevent law enforcement officers from engaging in motor activity include lack of free time (65.6 %), lack of desire (31.3 %), fatigue after a service day (28.1 %), etc.

It has been established that law enforcement officers who systematically engage in motor activity have a significantly (p < 0.001) better level of health (7.31 points) compared to those who engage in occasional motor activity (5.07 points) and do not engage in motor activity at all (2.19 points). The research has proven the positive impact of motor activity on the health of law enforcement officers. PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the dynamics of health indicators in law enforcement officers of different specialties during the performance of their service tasks under martial law.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Ivan M. Okhrimenko

National Academy of Internal Affairs 1 Solomyanska Square, 03035 Kyiv, Ukraine e-mail: ivango-07@ukr.net

ORCID AND CONTRIBUTIONSHIP

Ivan M. Okhrimenko: 0000-0002-8813-5107 A B Olena Yu. Pop: 0000-0001-7284-9685 D Nataliia V. Hresa: 0000-0002-0517-4822 B D Alla A. Shylina: 0000-0001-7377-0776 B Valentyna O. Tyurina: 0000-0003-2308-1977 E Oleksandr V. Bakanychev: 0009-0006-5198-7994 C Natalia A. Lyakhova: 0000-0003-0503-9935 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

The impact of strength loads on the health status and physical readiness of female cadets

Vasyl V. Prontenko¹, Maksym V. Pidoprygora², Dmytro V. Shtanagei³, Mykhailo I. Matviienko⁴, Valentyn P. Golub⁴, Mykola V. Bohovyk², Larysa M. Onishchuk ⁵

¹S.P. KOROLIOV ZHYTOMYR MILITARY INSTITUTE, ZHYTOMYR, UKRAINE ²MILITARY INSTITUTE OF TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV, KYIV, UKRAINE ³NATIONAL UNIVERSITY OF UKRAINE ON PHYSICAL EDUCATION AND SPORT, KYIV, UKRAINE ⁴NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE ⁵ NATIONAL UNIVERSITY «YURI KONDRATYUK POLTAVA POLYTECHNIC», POLTAVA, UKRAINE

ABSTRACT

Aim: To investigate the impact of kettlebell strength training on the health and physical readiness of female cadets during martial law training. Materials and Methods: The research involved 60 female cadets, 30 each in the experimental (EG) and the control (CG) groups. The EG cadets were engaged in kettlebell exercises during the hours of their sporting and mass participation activities, while the CG cadets were engaged according to the traditional methodology. The health status was assessed by anthropometry and cardiovascular system indicators; physical readiness – by the results of 100 meter run, push-ups, and 1 km run.

Results: It was found that at the end of the research, most indicators of health and physical readiness in female cadets engaged in kettlebell exercises were significantly better than those who were engaged in physical exercises according to the traditional methodology. The most pronounced effect of strength loads was found on the development of strength qualities, stabilization of body weight, and improvement of the functional capabilities of the cardiovascular system. In the 4th semester, the female cadets of the EG showed significantly better than in the CG indicators of BMI, SI, heart rate recovery time, LPH, results in push-ups, and 1 km run.

Conclusions: It is proved that strength loads in exercises with kettlebells, having several positive features, effectively impact the state of health and development of motor skills in female cadets, as well as contribute to the formation of an aesthetic physique and weight loss.

KEY WORDS: health, physical readiness, strength loads, kettlebell exercises, female cadets, martial law

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INTRODUCTION

According to statistical data, more than 43,000 servicewomen are currently serving in the Armed Forces of Ukraine, which is almost 3 times more than in 2014. Almost 8,000 women serve as officers, more than 11,000 as sergeants, almost 23,000 as soldiers, and more than 1,300 women are cadets in higher military educational institutions (HMEIs). More than 5,000 servicewomen perform tasks in the combat zone on an equal footing with men. The tendency to increase the number of women willing to serve is observed not only in the Armed Forces of Ukraine but also in other uniformed services and agencies of Ukraine, which is in line with the standards of NATO member states [1-3].

The current hostilities with the russian aggressor are accompanied by great physical and mental stress on military personnel, including women [4]. Constantly wearing a helmet, a body armor vest, a load-bearing system, with weapons and equipment, carrying arms materiel and ammunition, transporting the wounded, moving on the battlefield while overcoming obstacles, jumping on and off vehicles as well as armored vehicles, into trenches, fighting positions, jumping over them, etc. requires good health and a high level of motor skills in servicewomen, in particular the strength of the muscles of the back, legs, and shoulder girdle.

In this regard, there is a contradiction between the specifics, conditions, and requirements of modern military service and the educational process in HMEIs, on the one hand, and the anatomical and physiological characteristics of the female body and the level of development of their motor skills to ensure the quality of assigned tasks, on the other. This necessitates the search for effective means of physical training of female cadets

that would help to promote their health, increase the amount of motor activities, and improve the development of their motor skills. In addition, when selecting and justifying physical education means, it is necessary to take into account the current conditions of training female cadets during the legal regime of martial law (prolonged stay in shelters, bunkers during frequent air raids and missile danger) and the possibilities of the location of units (usually outside the permanent deployment point, in a limited space, without access to sports facilities) [5, 6]. Exercises with weights, in particular with kettlebells, can be one of the means of physical education of female cadets during the period of martial law, promoting their health and targeted development of back, leg, and shoulder girdle muscles [7, 8]. Exercises with kettlebells do not require much place and free space (exercises with kettlebells can be performed in bomb shelters, narrow and low rooms, in restricted space conditions, etc.) [9, 10]. However, no studies have been conducted on the impact of strength loads during kettlebell exercises under martial law on health and physical readiness of female cadets.

AIM

The aim is to investigate the impact of kettlebell strength training on the health and physical readiness of female cadets during martial law training.

MATERIALS AND METHODS

The research was conducted at the Military Institute of Taras Shevchenko National University of Kyiv in 2022-2024. The research involved 60 female cadets who entered the HMEI in 2022. In September 2022, we formed two groups of 30 female cadets each: the EG, which included female cadets who enrolled in the specialty 035 "Philology" and practiced during the hours of sporting and mass participation activities (SMPAs) according to the kettlebell complexes developed by the authors; the CG included female cadets who enrolled in the specialty 053 "Psychology" and practiced during the hours of SMPAs according to the traditional methodology. At the beginning of the research, there was no significant difference between the indicators of health status and physical fitness of female cadets.

Training sessions during the hours of SMPAs in both groups were held three times a week for 1 hour each; in the EG under the guidance of a kettlebell lifting coach, and in the CG – under the guidance of the cadet unit commander. For the EG, we developed a set of exercises with kettlebells weighing 8, 12, 16, 20, and 24 kg, which was aimed at strengthening the muscles of the back,

legs, and shoulder girdle in female cadets. The exercises in the course of training sessions were combined into sets of 5-7 exercises for the development of different muscle groups in female cadets. The main exercises with kettlebells for the EG included squats with a kettlebell, jumping up with a kettlebell, kettlebell swings, lifting, snatches, pulling, kettlebell deadlifts (bent-over rowing, chin deadlifts), kettlebell press standing, sitting, lying, etc. In the CG, training sessions were conducted with the use of gymnastic exercises (pull-ups on a low bar, push-ups, sit-ups, etc.) and exercises with body weight (bends, squats, jumps, jumping-ups, etc.). The exercises were also combined into sets of 5-7 exercises like in the EG. All training sessions in the EG and the CG were conducted in a circular method of 3-5 circles, depending on the complexity of the exercises and the duration of rest between exercises and circles. The research of indicators of health status and physical fitness of female cadets in the EG and the CG was carried out during 4 stages: during their training in the 1st, 2nd, 3^{rd,} and 4th semesters.

Research methods: theoretical (analysis, synthesis, generalization of literary sources), empirical (methods of health assessment, testing of physical qualities), methods of mathematical statistics. The health status of female cadets was assessed according to the methodology of Professor H.L. Apanasenko [11], which is based on anthropometric indicators (body weight and length, vital capacity of the lung, hand dynamometry), as well as the state of the cardiovascular system (heart rate, blood pressure, pulse recovery time). The methodology involved determining the sum of points for each of the 5 indicators (calculated indices): body mass index (BMI), vital index (VI), strength index (SI), Robinson index (RI), and heart rate recovery time (HRRT) after 20 squats in 30 seconds. According to the methodology of H.L. Apanasenko, low level of health corresponded to 3 or less points, below-average - 4-6 points, average - 7-11 points, above-average - 12-15 points, high level of health - 16-18 points. The physical readiness of female cadets was assessed by the following tests: 100 meter run, push-ups, and 1 km run. Testing was carried out in a sports uniform. One attempt was allowed for each exercise, and all exercises were tested within one day. The methods of mathematical statistics were applied to correctly process the data and identify the difference between EG and CG female cadets' indicators. The compliance of the data distribution with the Gauss' law was assessed using the Shapiro-Wilk W-test. The authenticity of the difference between the female cadets' indicators was determined by means of Student's test. The significance for all statistical tests was set at p<0.05. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all female cadets who took part in this research.

| Table 1 | . Dy | ynamics of health | indicators in female | cadets of the | EG and the CG duri | ig their training | g in the 1 st -4 | 4 th semesters at the H | $IMEI (M \pm m, n = 6)$ | 0) |
|---------|------|-------------------|----------------------|---------------|--------------------|-------------------|-----------------------------|------------------------------------|-------------------------|----|
|---------|------|-------------------|----------------------|---------------|--------------------|-------------------|-----------------------------|------------------------------------|-------------------------|----|

| Stages of research | EG (n=30) | CG (n=30) | Significance of difference, pEG-CG |
|--------------------|------------|------------------------|------------------------------------|
| | | BMI, kg/m ² | |
| 1 st | 21.3±0.34 | 21.4±0.31 | >0.05 |
| 2 nd | 21.0±0.32 | 21.8±0.29 | >0.05 |
| 3 rd | 20.7±0.30 | 21.9±0.29 | <0.05 |
| 4 th | 20.6±0.29 | 22.0±0.30 | <0.01 |
| p1-4 | >0.05 | >0.05 | |
| | | VI, ml/kg | |
| 1 st | 49.8±1.42 | 50.2±1.40 | >0.05 |
| 2 nd | 52.3±1.39 | 51.5±1.41 | >0.05 |
| 3 rd | 53.7±1.38 | 52.1±1.39 | >0.05 |
| 4 th | 54.9±1.37 | 53.4±1.40 | >0.05 |
| p1-4 | <0.05 | >0.05 | |
| | | SI, % | |
| 1 st | 40.2±1.24 | 40.4±1.22 | >0.05 |
| 2 nd | 44.8±1.22 | 40.5±1.18 | <0.05 |
| 3 rd | 49.3±1.21 | 40.6±1.19 | <0.001 |
| 4 th | 53.9±1.19 | 40.5±1.17 | <0.001 |
| p1-4 | <0.001 | >0.05 | |
| | | RI, c. u. | |
| 1 st | 80.9±1.44 | 80.7±1.38 | >0.05 |
| 2 nd | 80.2±1.41 | 80.5±1.37 | >0.05 |
| 3 rd | 79.6±1.39 | 80.4±1.37 | >0.05 |
| 4 th | 78.8±1.38 | 80.2±1.36 | >0.05 |
| p1-4 | >0.05 | >0.05 | |
| | | HRRT, s | |
| 1 st | 135.1±3.60 | 134.9±3.54 | >0.05 |
| 2 nd | 124.4±3.43 | 129.6±3.48 | >0.05 |
| 3 rd | 116.2±3.37 | 122.6±3.45 | >0.05 |
| 4 th | 107.6±3.29 | 117.5±3.42 | <0.05 |
| p1-4 | <0.001 | <0.01 | |
| | | LPH, points | |
| 1 st | 4.03±0.82 | 4.13±0.71 | >0.05 |
| 2 nd | 6.92±0.79 | 4.82±0.70 | >0.05 |
| 3 rd | 7.37±0.80 | 5.27±0.69 | <0.05 |
| 4 th | 9.41±0.77 | 5.90±0.68 | <0.01 |
| p1-4 | <0.001 | >0.05 | |

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of female cadets; t – t-test value; p – significance of difference between the indicators of female cadets.

RESULTS

The results of the research of health indicators of the EG and the CG female cadets are given in Table 1. The analysis of BMI showed that during the 1st and 2nd semesters, the indicators of the EG and the CG did not differ significantly (p > 0.05). In the 3rd and 4th semesters BMI in the EG female cadets, due to stabilization of

body weight, was significantly better than in the CG, by 1.2 and 1.4 kg/m², respectively (p < 0.05; p < 0.01). During the study period, BMI in the EG improved by 0.7 kg/m², and in the CG – deteriorated by 0.7 kg/m², but no significant difference was revealed between the indicators of the 1st and 4th semesters (p > 0.05) in both groups. At the same time, BMI was within the age norm

| Stages of research | EG (n=30) | CG (n=30) | Significance of difference, pEG-CG |
|---------------------|------------|-----------------|------------------------------------|
| | 1 | 00 meter run, s | |
| 1 st | 16.9±0.18 | 16.8±0.20 | >0.05 |
| 2 nd | 16.7±0.17 | 16.7±0.19 | >0.05 |
| 3 rd | 16.6±0.17 | 16.6±0.19 | >0.05 |
| 4 th | 16.5±0.16 | 16.6±0.18 | >0.05 |
| p1-4 | >0.05 | >0.05 | |
| | F | Push-ups, times | |
| 1 st | 22.4±0.85 | 22.3±0.72 | >0.05 |
| 2 nd | 23.9±0.79 | 22.8±0.70 | >0.05 |
| 3 rd | 25.7±0.73 | 24.8±0.68 | >0.05 |
| 4 th | 29.3±0.66 | 27.1±0.65 | <0.05 |
| p1-4 | <0.001 | <0.001 | |
| | | 1 km run, s | |
| 1 st | 292.3±2.38 | 296.9±2.55 | >0.05 |
| 2 nd | 281.5±2.19 | 285.1±2.39 | >0.05 |
| 3 rd | 277.2±2.07 | 282.5±2.34 | >0.05 |
| 4 th | 269.7±1.98 | 277.5±2.18 | <0.05 |
| p1-4 | <0.001 | <0.001 | |

Table 2. Dynamics of physical readiness indicators in female cadets of the EG and the CG during their training in the 1st-4th semesters at the HMEI ($M \pm m$, n = 60)

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of female cadets; t – t-test value; p – significance of difference between the indicators of female cadets.

and corresponded to the average level in both groups. No significant difference was found in VI between the EG and the CG at all stages of the research (p > 0.05), but in the EG the functional capacity of the respiratory system improved significantly (p < 0.05) during the training period in the 1st – 4th semesters by 5.1 ml/kg, and in the CG the changes, which amounted to 3.2 ml/kg, were not significant (p > 0.05). At the beginning of the research in both groups, VI corresponded to a below-average level, and at the end – to the average level.

A positive, pronounced effect of strength loads on the body of female cadets was established by the indicators of SI. Thus, a significant difference between the indicators of SI in female cadets of the EG and the CG was found already in the 2^{nd} semester – 4.3 % (p < 0.05), and in the 3rd and 4th semesters the indicators of SI in the EG were significantly better than in the CG by 8.7 % and 13.4% (p < 0.001). During the training, the strength capabilities of female cadets of both groups improved, but a significant difference between the indicators of the 1st and 4th semesters was found only in the EG (13.7%; p < 0.001), which indicated the effectiveness of strength exercises with kettlebells on the development of muscle strength in female cadets. The analysis of RI showed that both groups were characterized by an improvement in the functional capabilities of female

cadets' cardiovascular system, corresponding to the above-average level, but a significant difference at any stage of the research was not found (p > 0.05). The dynamics of the HRRT in women of both groups was positive for the period of the research, and the difference between the initial and final data in both EG and CG was reliable (p < 0.001; p < 0.01), but better HRRT by 9.9 s was recorded (p < 0.05) in the EG women during their 4th semester of training

The analysis of the level of physical health (LPH) according to the method of H. L. Apanasenko showed that in both groups there was an improvement in the health of female cadets during their training at the HMEI. However, during the research period, the LPH in the EG improved by 5.38 points (p < 0.001), and in the CG – by 1.77 points (p > 0.05). At the end of the research, the LPH in the EG was 3.51 points higher than in the CG (p < 0.01). At the same time, starting from the 2nd semester, the LPH in the EG was assessed as "average", and in the CG at all stages of the research - "below-average". This indicates the positive impact of kettlebell strength training on the health status of female cadets during their training in the 1st-4th semesters. In the case of continuation of exercises with kettlebells, it is possible to predict further improvement of the health status of female cadets to above-average and high levels in the senior years of training.

The results of the assessment of physical readiness indicators in female cadets of the EG and the CG during their training in the 1st-4th semesters at the HMEI are presented in Table 2. It was found that for all tests at the beginning of the research, there was no significant difference between the indicators of the EG and the CG (p > 0.05). The study of results characterizing the development of high-speed qualities shown by female cadets in 100 m runs indicates that in both groups there was an improvement of results by 0.4 and 0.2 s respectively (p > 0.05), but between the EG and the CG, there was no significant difference at all stages of the research (p > 0.05). This indicates that both strength loads with kettlebells and traditional training sessions during the hours of SMPAs have a positive effect on the development of speed qualities of female cadets. In the 4th semester, the results of 100 meter run in the EG were evaluated as "good", and in the CG - as "satisfactory".

The dynamics of the development of strength qualities in female cadets of the EG and the CG was positive, but the growth of results in the EG prevailed over the CG, starting from the 2nd semester. The difference between the results of female cadets of the EG and the CG in the 2^{nd} semester was 1.1 times (p > 0.05), in the 3^{rd} – 0.7 times (p > 0.05), and in the 4^{th} – 2.2 times (p < 0.05). At the same time, during the research period the results of the EG significantly increased by 6.9 times (p < 0.001) and were estimated in the 4th semester as "excellent", and in the CG – by 4.8 times (p < 0.001), the grade was "good". The research of endurance development level by results of 1 km run testified to a significantly (p < 0.001) positive dynamics of results in both groups. At the same time, in the 1st-3rd semesters there was no significant difference between indicators of the EG and the CG, and in the 4th semester indicators in the EG were significantly better than in the CG by 7.8 s (p < 0.05). This allows us to assert that strength loads during kettlebell training not only did not interfere with the development of endurance in female cadets but even contributed to its development. In the 4th semester, the results of running 1 km in both groups were rated as "excellent". In general, strength loads during kettlebell training had a positive impact on both the health and physical readiness indicators of female cadets.

DISCUSSION

According to scientists [7, 12], today strength exercises with weights and, in particular, with kettlebells are quite popular among the female half of humanity. This is evidenced by a significant number of competitions in strength sports in our country and abroad among

students, girls, and women; an annual growth in the number of female participants in these competitions and an increase in the level of their physical fitness and sportsmanship; inclusion of kettlebell exercises in various health and fitness programs for women, CrossFit training, weight loss programs, etc. However, strength loads during weight-bearing exercises require taking into account certain anatomical and physiological features of the female body compared to the male body to maximize the benefits of training. When comparing the functional capabilities of women and men, it is necessary to take into account the difference in body size, the capabilities of the muscular system, as well as the rhythmic functioning of the ovarian-menstrual cycle (OMC). Experts [13] note that the total muscle strength in women is about 70 % of this indicator in men; women have relatively weak muscles of the upper extremities and trunk, and their maximum strength is 40-70 % of the strength of these muscles in men. At the same time, the strength of the leg muscles in women is only 2.7 % less than in men [14]. Working muscle hypertrophy, which is regulated mainly by sex hormones, is less pronounced in women than in men. Therefore, strength training has a greater effect on reducing adipose tissue in women and a relatively smaller effect on increasing muscle volume. In men, muscles make up about 40-50 % of body weight, in women about 30 %; the amount of adipose tissue in men is about 20 %, in women – 30 % of body weight [15]. The vital capacity of the lungs in men is 4300-4600 ml, in women - 3200-3400 ml; the resting heart rate in men is 62-72 beats per minute, in women – 70-80 beats per minute; the heart in women is 10-20 % smaller than in men. Women have an increased excitability of the nervous system, a longer recovery period after strength training, and a rapid loss of fitness in the event of a training interruption.

In the works of scientists [9, 16], the advantages of kettlebell exercises in the absence of the possibility of using other sports equipment are noted: simplicity and accessibility of exercises for people of different sexes and ages, as well as with different levels of physical fitness, compactness of equipment, content-richness (the total number of kettlebell exercises can be more than 100), wellness orientation, minimal injury rate, cost-effectiveness, etc. All you need for kettlebell training is a set of kettlebells of different weights. Kettlebell training does not require any special conditions: it can be done outdoors and in confined spaces, and you can do it alone or in a group. Systematic kettlebell exercises contribute to the development of strength, endurance, and coordination of movements; improve body structure; help to improve self-confidence, self-esteem, perseverance, and determination [10, 17]. The availability of kettlebell exercises for women with different physical development allows them to effectively solve the problems of body shaping and physique correction (weight loss, weight reduction, strengthening of abdominal and back muscles), strengthening of the musculoskeletal system, cardiovascular and respiratory systems [8, 18]. Muscle "corset" ensures the correct position and functioning of the spine and internal organs in women, improves blood supply to the brain, and, as a result, increases mental and physical performance. In the process of training with kettlebells, women also learn vital skills and abilities to handle weights correctly. All of the above confirms the expediency of using strength loads in kettlebell exercises for female cadets, forming in them all the necessary motor and psychological qualities necessary for their educational and future military professional as well as combat activities.

Researches are devoted to the problem of improving the level of physical fitness of servicewomen [19, 20]. The question of the use of means of kettlebell sport for the development of motor qualities of servicemen and male cadets, and also improvement of their sports results was the subject of scientific research by some scientists. However, the use of exercises with kettlebells in the physical training of female cadets to promote their health status, and increase the level of development of their strength qualities during training at HMEIs during the period of the right regime of martial law remained without the attention of specialists. The results of our research have expanded the conclusions of existing works [9, 10, 18] on the benefits of strength loads on the health status and physical readiness of military personnel.

CONCLUSIONS

It was found that at the end of the research, most indicators of health and physical fitness in female cadets engaged in kettlebell exercises were significantly (p < 0.05-0.001) better than those who were engaged in physical exercises according to the traditional methodology. The most pronounced effect of strength loads was found on the development of strength qualities, stabilization of body weight in women, and improvement of the functional capabilities of the cardiovascular system. In the 4th semester, the female cadets of the EG showed significantly better than in the CG indicators of BMI, SI, heart rate recovery time, LPH, results in pushups, and 1 km run. It is proved that strength loads in exercises with kettlebells, having several positive features, effectively impact the state of health and development of motor skills in female cadets, as well as contribute to the formation of an aesthetic physique and weight loss.

The level of health and physical readiness formed in the 1st and 2nd training years will help to increase the body's resistance to adverse factors of educational activities, improve the efficiency of performance of service duties, and the formation of military-applied skills in female cadets during their senior training years and in the course of their future military professional as well as combat activities.

THE PROSPECT OF FURTHER RESEARCH

It is planned to investigate the effect of strength loads in kettlebell exercises on the restoration of the psycho-emotional state of female cadets in a war.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Larisa M. Onishchuk

Yuri Kondratyuk Poltava Polytechnic 24 Pershotravnevy prospect, 36000 Poltava, Ukraine e-mail: larpolt_turizm@ukr.net

ORCID AND CONTRIBUTIONSHIP

Vasyl V. Prontenko: 0009-0002-3559-3232 A D Maksym V. Pidoprygora: 0000-0003-0659-2003 A D Dmytro V. Shtanagei: 0000-0001-5675-5582 C Mykhailo I. Matviienko: 0000-0002-2162-7967 E Valentyn P. Golub: 0009-0009-1122-6033 E Mykola V. Bohovyk: 0009-0006-6235-1326 B Larysa M. Onishchuk: 0000-0002-5411-149X C F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Characteristics of 16-17-year-old young males' physical development in the process of judo club activities

Grygoriy P. Griban¹, Vasyl V. Yahupov², Valentyna I. Svystun², Valentyna A. Filina¹, Oksana P. Kanishcheva³, Viktoriia B. Bakuridze-Manina⁴, Iryna S. Oliinyk⁵

¹ZHYTOMYR IVAN FRANKO STATE UNIVERSITY, ZHYTOMYR, UKRAINE ²NATIONAL DEFENSE UNIVERSITY OF UKRAINE, KYIV, UKRAINE ³KHARKIV STATE ACADEMY OF PHYSICAL CULTURE, KHARKIV, UKRAINE ⁴DNIPRO STATE MEDICAL UNIVERSITY, DNIPRO, UKRAINE ⁵BOGDAN KHMELNITSKY MELITOPOL STATE PEDAGOGICAL UNIVERSITY, ZAPORIZHZHIA, UKRAINE

ABSTRACT

Aim: To investigate the influence of judo club activities on the physical development indicators of 16-17-year-old young males.

Materials and Methods: The research, conducted in 2022-2024, involved 54 young males aged 16-17, who were divided into experimental (EG) and control (CG) groups of 27 each. The physical development was assessed by body weight, hand dynamometry, lung capacity, heart rate, and blood pressure indicators. Cooper, Rufier, Stange, Genchi, vital, strength, body weight, Robinson, and maximum oxygen consumption indices were calculated.

Results: The positive influence of judo club activities on the physical development of 16-17-year-old young males was revealed: all studied indicators significantly improved in the EG young males during the experiment. Judo training sessions had the most effective impact on the indicators characterizing the development of the muscular system and the level of strength qualities. At the end of the experiment, young males of the EG showed significantly better physical development than the CG representatives in terms of strength index (by 6.33 %), static endurance of stronger (by 2.07 s) and weaker (2.03 s) hands. According to the indicators characterizing the state of cardiovascular and respiratory systems, the indicators of young males of both groups were significantly the same. **Conclusions:** It has been established that judo club activities, which were conducted taking into account the age characteristics of 16-17-year-old young males, create the most favorable conditions for the harmonious physical development of boys, promoting their health and preparing them for future educational and professional activities.

KEY WORDS: physical development, health, young males, high schoolers, judo

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INTRODUCTION

The socio-economic and political crisis in the country's development, martial law, and the aggravation of global problems of our time have given rise to certain negative conditions in the younger generation, such as social anxiety, cruelty, indifference, and, as a result, the spread of alcoholism, drug addiction, and other criminal manifestations in society. One of the ways to overcome such negative phenomena is to provide conditions for the personal growth of high schoolers and, the realization of an active life stance of each of them. This task is impossible without modernizing the educational process of physical education at school [1, 2]. Today, Ukrainian schools are actively searching for new forms, methods, and means of physical education that would help improve the health of high schoolers, their psycho-emotional state, physical development,

and physical as well as moral and volitional qualities. According to experts [3, 4], the basis of new approaches to the modernization of physical education in general secondary educational institutions can be a personality-oriented approach, which provides for the compliance of the forms, means, methods, and conditions of education used with the individual psychological characteristics of high schoolers, as well as the freedom to choose the physical activity that best suits the personal abilities of each of them.

One of the means of physical education for high schoolers, improvement of their physical development, health promotion, and preparation for life-sustaining activities can be different types of martial arts, among which judo occupies an important place [5, 6]. Judo is an effective means of physical training for the younger generation and, therefore, is of great practical importance; it helps to promote their health; increase the level of physical development and fitness; contributes to the improvement of physical qualities; development of positive motivation and a stable need for exercise and sports [7, 8]. Due to the wide variety of techniques and actions that make up the content of judo training sessions, as well as the great educational, health, and applied value of judo, it is included in the programs of sports competitions of city, regional, national, European and world scales [9, 10]. On the one hand, it is a means of comprehensive physical development available to all and an auxiliary means of developing physical qualities in other sports, and on the other hand, judo is a means of popularizing speed and strength sports and promoting a healthy lifestyle among high schoolers [11, 12]. Despite the existence of a significant number of studies, the problem of physical development of 16-17-year-old high schoolers in general secondary educational institutions through judo remains insufficiently disclosed.

AIM

The aim is to investigate the influence of judo club activities on the physical development indicators of 16-17-year-old young males.

MATERIALS AND METHODS

The research was conducted in 2022-2024 based on secondary school No. 20 with enhanced physical training (Zhytomyr, Ukraine) and Zhytomyr Ivan Franko State University. The research involved 54 young males aged 16-17 years (10-11 grades high schoolers), who were divided into the experimental (EG) and the control (CG) groups of 27 each. The young males of the EG were engaged in judo club activities according to the author's methodology, and the young males of the CG were engaged in various sports: volleyball (8 persons), basketball (10 persons), swimming (4 persons), and athletics (5 persons). The number of hours of training sessions in each group was 110 hours over the 9 months of the experiment. The duration of one training session in both groups was 45 minutes. Training sessions in the EG and the CG were held 3 times a week after school hours, in the afternoon.

The content of educational material according to the author's methodology is built following age peculiarities of 16-17-year-old high schoolers (taking into account sensitive regularities of physical qualities development); it includes means, methods, and forms of training; provides regulation of physical activity during the year and separate educational and training session; formation of harmonious physical development; strengthening of physical health and increasing functional capabilities of an organism; formation of motivation for motor activity, taking into account the interests of high schoolers to express themselves and manifest their potential in educational and training activities.

The author's methodology included: the distribution of high schoolers by levels of their physical fitness; variability of methods and means; a set of general developmental and special developmental exercises; studying the technique of performing judo techniques and combinations of techniques; regulation of the volume and intensity of the load during training sessions; application of group form of training with a differentiated and individual approach; use of various teaching methods; use of special action-oriented games with elements of wrestling; use of pedagogical and operational control over the state of health of high schoolers, their technical and physical fitness. Judo techniques were learned during training sessions, with the components of the technique, amplitude, speed, and the degree of effort in different phases of the technique being mastered. New material was learned in whole or in parts. Training sessions in the EG and the CG were conducted by coaches of the mentioned sports during the hours of club training activities at school.

The following scientific methods were used in the research: analysis and generalization of literature sources, medical and biological methods, pedagogical experiment, and methods of mathematical statistics. The analysis and generalization of literature sources allowed us to define the problem field of the research, to get a general idea of the degree of development of the problem under study, to identify basic data on the following topics: age characteristics of high schoolers, the impact of judo training on the body of young males (25 sources from the scientometric databases PubMed, Scopus, Index Copernicus, and others were investigated). Medical and biological methods were used to assess the physical development of young males in terms of height, body weight, hand dynamometry, vital capacity of the lungs, heart rate, and blood pressure indicators. The following indices were calculated: Cooper, Rufier, Stange, Genchi, vital, strength, body weight, Robinson, and maximum oxygen consumption (MOC) [13]. During the pedagogical experiment, we implemented the author's methodology and tested its influence on the level of physical development of young males aged 16-17 years who were engaged in judo club activities for 2 years (from September 2022 to May 2024). During the researches the authenticity of difference between the indicators of high schoolers by means of Student's t-test was determined. The dynamics of indicators in each of groups was also estimated. The significance for all statistical tests was set at p<0.05. All statistical analyses were performed with the SPSS software, version 22, adapted to medical and biological researches. This research followed the reg-

| able 1. Characteristics of physical developmen | t of 16-17-year-old y | oung males of the EG and the | CG before the experiment | $(n = 54, M \pm m)$ |
|--|-----------------------|------------------------------|--------------------------|---------------------|
|--|-----------------------|------------------------------|--------------------------|---------------------|

| Indicators of physical development | EG (n=27) | CG (n=27) | t | р |
|---|--------------|--------------|------|-------|
| Cooper index, m | 1677.5±21.31 | 1684.7±23.17 | 0.23 | >0.05 |
| Body length, cm | 175.4±1.08 | 176.3±1.02 | 0.61 | >0.05 |
| Body weight, kg | 70.9±0.98 | 71.2±0.91 | 0.22 | >0.05 |
| BMI, kg/m2 | 23.08±0.35 | 22.91±0.39 | 0.32 | >0.05 |
| Strength index, % | 64.23±1.78 | 63.58±1.82 | 0.26 | >0.05 |
| Vital index, ml/kg | 61.12±1.84 | 61.86±1.82 | 0.29 | >0.05 |
| Static endurance of the stronger hand, s | 7.31±0.76 | 7.46±0.67 | 0.15 | >0.05 |
| Static endurance of the weaker hand, s | 6.02±0.72 | 5.84±0.68 | 0.18 | >0.05 |
| Resting heart rate, bpm-1 | 72.43±1.15 | 72.13±1.17 | 0.18 | >0.05 |
| Rufier test, c. u. | 13.26±0.45 | 12.85±0.40 | 0.68 | >0.05 |
| Stange test, s | 46.53±1.86 | 45.57±2.35 | 0.32 | >0.05 |
| Genchi test, s | 30.73±0.66 | 29.83±0.54 | 1.06 | >0.05 |
| Robinson index, c. u. | 86.91±1.23 | 86.55±1.16 | 0.21 | >0.05 |
| MOC, ml·min ⁻¹ ·kg ⁻¹ | 28.9±0.56 | 30.3±0.64 | 1.65 | >0.05 |

Legend: t – Student's t-test value; p – authenticity of difference between the indicators of the EG and the CG.

| Table 2. Characteristics of physical development of 16-17-year-old young males of the EG and the CG after the experiment (n = 54, I | M±m) |
|---|------|
|---|------|

| Indicators of physical development | EG (n=27) | CG (n=27) | D | t | р |
|---|--------------|--------------|------|------|-------|
| Cooper index, m | 2881.7±22.45 | 2825.6±23.17 | 56.1 | 1.74 | >0.05 |
| Body length, cm | 176.9±0.97 | 177.1±0.95 | 0.20 | 0.15 | >0.05 |
| Body weight, kg | 71.4±0.86 | 72.1±0.89 | 0.70 | 0.57 | >0.05 |
| BMI, kg/m2 | 22.87±0.31 | 22.89±0.33 | 0,02 | 0.04 | >0.05 |
| Strength index, % | 73.57±1.64 | 67.24±1.74 | 6.33 | 2.65 | <0.05 |
| Vital index, ml/kg | 66.54±1.92 | 65.91±1.89 | 0.63 | 0.23 | >0.05 |
| Static endurance of the stronger hand, s | 14.70±0.63 | 12.63±0.65 | 2.07 | 2.29 | <0.05 |
| Static endurance of the weaker hand, s | 11.80±0.59 | 9.77±0.64 | 2.03 | 2.33 | <0.05 |
| Resting heart rate, bpm-1 | 67.60±0.86 | 69.08±0.97 | 1.48 | 1.14 | >0.05 |
| Rufier test, c. u. | 7.72±0.31 | 8.31±0.36 | 0.59 | 1.24 | >0.05 |
| Stange test, s | 58.17±1.54 | 55.46±1.84 | 2.71 | 1.13 | >0.05 |
| Genchi test, s | 37.24±0.53 | 35.61±0.55 | 0.63 | 0.82 | >0.05 |
| Robinson index, c. u. | 81.12±1.07 | 82.90±1.11 | 1.78 | 1.15 | >0.05 |
| MOC, ml·min ⁻¹ ·kg ⁻¹ | 39.8±0.39 | 38.8±0.52 | 1.00 | 1.54 | >0.05 |

Legend: D – the magnitude of the difference in the indicators of the EG and the CG; t – Student's t-test value; p – authenticity of difference between the indicators of the EG and the CG.

ulations of the World Medical Association Declaration of Helsinki – ethical principles for medical research involving human subjects. Consent to voluntary participation in the survey was obtained from all the respondents involved in the research.

RESULTS

Characteristics of physical development of 16-17-yearold young males of the EG and the CG before the experiment are given in Table 1. Analysis of Table I showed that the EG and the CG have no significant difference (p > 0.05) in all indicators of physical development. At the same time, the majority of indicators in young males of both groups were at a low level or below average.

The analysis of indicators of physical development in young males of the EG and the CG after the experiment testifies that by indicators characterizing the development of the muscular system and a level of strength qualities, in the young males of the EG physical development was significantly (p < 0.05) better than in the CG representatives (Table 2). Thus, after the experiment, the EG young males have significantly better indicators in terms of their strength index (by 6.33 %), and static endurance of a stronger hand (by 2.07 s) and a weaker hand (2.03 s) than in the CG representatives. This proves the effectiveness of judo training, compared to other sports, in improving the physical development of 16-17-year-old young males. Instead, according to the indicators characterizing the functional state of the cardiovascular and respiratory systems, the indicators of young males of both groups were significantly the same after the experiment (p > 0.05). It should be added that during the experiment there was a significant (p < 0.05, p < 0.001) improvement of all studied indicators of physical development in both groups of young males. Most of the indicators that were evaluated, in particular Cooper, strength, vital, Robinson indices, Rufier, Stange, Genchi, and MOC tests, correspond to average and above average levels after the experiment.

The conducted research allows us to assert that club extracurricular training sessions in any sport, provided that young males make a conscious motivated choice of a sport for training, contribute to the improvement of certain indicators of physical development of 16-17-year-old young males. Thus, according to the results of our research, it was found that sports games, athletics, swimming, and, of course, judo, have a positive effect on the indicators of the muscular system, as well as on the cardiovascular and respiratory systems. However, judo training sessions, given the specifics of this sport, have a greater impact on the development of strength qualities in 16-17-year-old young males than in other sports.

DISCUSSION

In recent years, Ukraine has seen a negative trend in the dynamics of health indicators, including those of schoolchildren, which has led to an increase in the number of scientific studies [14, 15] that point to the low physical fitness of high schoolers, a lack of motor activity, a decline in their physical development and the growth of bad habits. At the same time, many scientific papers [16] reflect attempts to update and improve their physical education process and offer various approaches to the construction and organization of both fixed and extracurricular forms of physical education, i.e. its modernization. In connection with the reform of education in Ukraine, the creation of the New Ukrainian School (NUS), radical changes are taking place in all types of activities, including physical education and sports activities. In addition, due to the transition to a twelve-year education system, which is caused by an increase in the knowledge that high schoolers need to acquire in the course of their schooling, it is necessary to reconsider the attitude to regular sporting and mass

participation events. After all, an increase in mental load for the full perception of educational material can be achieved through regular, rationally organized physical exercises and sports [17]. Some scientists [18] focus on current areas of improvement in the system of physical education of high schoolers. It is important to take into account age peculiarities and anatomical, physiological, and sensory regularities of physical qualities and abilities development in high schoolers of general secondary education institutions in the process of planning educational and training sessions. To develop and improve the physical qualities of high schoolers, in particular strength, various means are used, among which martial arts, in particular judo, play an important role [19, 20]. The development of strength abilities in high schoolers occurs in the period from 9 to 18 years, but the highest growth rates are observed from 16 to 17 years. During training or competitive judo matches, high schoolers are in direct physical contact most of the time, forcing the neuromuscular system to work in a dynamic mode and significant tension. Under such conditions of training or competitive fights, a high level of speed and strength abilities develops [21]. Scientists [22] have found that as a result of systematic judo training, the volume of the heart muscle gradually increases, the network of blood vessels expands; changes occur in the blood composition (the number of red blood cells, hemoglobin increases); chest circumference and lung capacity increase; the activity of the central nervous system and mental performance improves; the intensity and concentration of attention increase, physical qualities, especially strength abilities, develop and improve.

As noted by scientists [23], the main means of solving the problems of strength training in judo sessions are various special preparatory exercises performed with a partner and separately, using shock absorbers, rubber harnesses, and weights. They are selected taking into account one or more motor elements of the chosen technical and tactical technique or combination. It is also possible to use separate training and competitive fights with an emphasis on the strength effect. Having in service highly effective methods of influence on an organism, it is possible to considerably reduce terms of development of strength abilities and, accordingly, to carry out more flexible management of the educational and training process [24]. In the process of judo training sessions, according to scientists [25], the following methods aimed at the development of strength abilities are most widely used: the method of maximum effort, the method of dynamic effort, the repeated method, the method of circular training, the game method, the sensory method, the "shock" method, the method of isometric effort, the competitive method, the acceleration method, the variable method. The choice of a particular method is determined by the purpose and tasks of the educational and training session taking into account the individual level of development of physical qualities and strength abilities of high schoolers. Our research has shown that club training sessions of any sport promote improvement of certain indicators of physical development in 16-17-year-old young males, however, judo activities, in comparison with other sports, more effectively influence the development of strength qualities of 16-17-year-old young males.

CONCLUSIONS

The positive influence of judo club activities on the physical development of 16-17-year-old young males was revealed: all studied indicators significantly improved in the EG young males during the experiment. However, judo training sessions had the most effective impact on the indicators characterizing the develop-

ment of the muscular system and the level of strength qualities. At the end of the experiment, young males of the EG showed significantly (p < 0.05) better physical development than the CG representatives in terms of strength index (by 6.33%), static endurance of stronger (by 2.07 s) and weaker (2.03 s) hands. According to the indicators characterizing the state of cardiovascular and respiratory systems, the indicators of young males of both groups were significantly the same (p > 0.05).

It has been established that judo club activities, which were conducted taking into account the age characteristics of 16-17-year-old young males, create the most favorable conditions for the harmonious physical development of boys, promoting their health and preparing them for future educational and professional activities.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the influence of judo club activities on the level of physical fitness of 16-17-yearold young males in comparison with other sports.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Grygoriy P. Griban

Zhytomyr Ivan Franko State University 40 Velyka Berdychivska St, 10008 Zhytomyr, Ukraine e-mail: gribang@ukr.net

ORCID AND CONTRIBUTIONSHIP

Grygoriy P. Griban: 0000-0002-9049-1485 (A) (B) Vasyl V. Yahupov: 0000-0002-8956-3170 (E) Valentyna I. Svystun: 0000-0002-7934-023X (D) Valentyna A. Filina: 0000-0002-1244-0543 (B) (D) Oksana P. Kanishcheva: 0000-0002-5030-5318 (C) Viktoriia B. Bakuridze-Manina: 0000-0002-2108-814X (C) (F) Iryna S. Oliinyk: 0000-0003-1888-1187 (F)

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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ORIGINAL ARTICLE

CONTENTS 🔼

Health-promoting effect for students from physical loads of speed and strength orientation

Oleksii V. Tymoshenko¹, Zhanna H. Domina¹, Valentyna H. Bilyk¹, Yurii P. Serhiienko², Oleksandr M. Lavrentiev², Nataliia A. Dakal³, Petro S. Horhol⁴

¹UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE

²STATE TAX UNIVERSITY, IRPIN, UKRAINE

³NATIONAL TECHNICAL UNIVERSITY OF UKRAINE "IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE", KYIV, UKRAINE ⁴ NATIONAL UNIVERSITY «YURI KONDRATYUK POLTAVA POLYTECHNIC», POLTAVA, UKRAINE

ABSTRACT

Aim: To investigate the impact of speed and strength physical loads on promoting health and reducing the biological age of student youth.

Materials and Methods: The research involved 180 students aged 18-19. The first stage provided for the study of the indicators of the biological age of 120 students, and the second stage covered substantiation of the methodology for martial arts training sessions, based on physical loads of speed and strength orientation. To test its effectiveness, 60 students were involved (30 were in the experimental group (EG), 30 – in the control group (CG)).

Results: The methodology for martial arts training sessions was developed and tested. In the dynamics of the experiment, there is a tendency to a decrease in the difference between the biological and the passport age, but these changes were unreliable in the CG, while a statistically significant decrease in this difference was recorded in the EG. In addition, there were significant changes in the EG in the following indicators: inspiratory breath holding (11.6%), subjective health assessment (38.5%), and static balancing (20.0%).

Conclusions: The use of physical loads of speed and strength orientation in the course of martial arts training has established a health-promoting effect and positive dynamics of the biological age indicators of student youth. The results of the research can be implemented in physical education and the process of sports improvement of students in higher educational institutions.

KEY WORDS: health, biological age, students, martial arts, physical education

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INTRODUCTION

The current conditions of production development are constantly depleting human biological and functional reserves. Adaptation processes are disrupted, maladaptation syndrome develops and, as a result, pathology progresses [1]. One of the indicators of human adaptation is biological age, which should be taken into account to predict individual health, as it makes it possible to assess the degree of compliance of the biological development of the body with the calendar age of a person, reflects the rate of biological aging, which determines the level of functioning of the main life support systems and life expectancy. Differences between the calendar and biological ages make it possible to assess the intensity of aging and the level of functional capabilities of an individual [2].

The analysis of the life expectancy and quality of life of Ukrainians shows that over the past decade, there has

been a sharp deterioration in the health of the population of all ages, including students. The peculiarities of students' education in recent years are characterized by a decrease in motor activity and an increased level of stress against the background of intensification of the educational process in the context of distance learning due to quarantine restrictions and martial law, which causes premature aging of their bodies [3, 4].

The biological age characterizes the level of wear and tear of the body as a whole by comparing the actual values of individual biomarkers with the norms of these values according to the calendar age [5]. Various studies have shown that the biological age of students ranges from 40 to 46 years on average. The discrepancy between the biological and the passport age ranges from 10 to 40 years, while 15-20 years ago the difference between the calendar and the biological age was 4-5 years [6]. Since the body's aging rate can have a real predictive value for assessing an individual's health, the study of the biological age of students is an important measure for pedagogical control of the effectiveness of physical education in higher education. At the same time, rationally organized motor activity, which arouses interest and has a comprehensive health-promoting effect, has potential opportunities for pedagogical influence on slowing down the age-related aging processes in students' bodies.

Studies show that various types of martial arts are in special demand among male students. Martial arts training helps to increase the overall performance of the body, develop motor skills, and improve the functional capabilities of the body in the conditions of different motor modes of muscle function.

The level of motor fitness of students depends largely on the focus of the educational process, its structure, content, methods, and means of physical education. By choosing a particular sport for training sessions, students try to meet their individual biological and psychological needs for motor activity [7, 8, 9]. In recent years, many researchers have addressed the problem of improving the organization of health-promoting physical education training sessions for students using different types of martial arts [10, 11]. However, it is still important to study the influence of speed and strength exercises on reducing the biological age of students in the process of their physical education.

AIM

The aim is to investigate the impact of speed and strength physical loads on promoting health and reducing the biological age of student youth.

MATERIALS AND METHODS

The research was conducted in 2022-2023. The research involved 180 students of pedagogical specialties of the Ukrainian State Dragomanov University aged 18-19 who had not been involved in sports before entering the higher educational institution. The first stage of the experiment (ascertaining, 2022) provided for the study of the biological age of 120 students, and the second (formative, September 2022 – May 2023) substantiated the methodology for martial arts training sessions based on physical loads of speed and strength orientation. To test its effectiveness, 60 students were involved. The experimental (EG) and the control (CG) groups of 30 people were formed, respectively. The EG students, in addition to compulsory physical education training sessions according to the schedule 2 times a

week (4 hours), attended sports club martial arts training sessions 3 times a week (6 hours), which amounted to 10 hours of exercise per week. The CG students were engaged in a traditional physical education program (4 hours of compulsory training sessions) and attended optional or sports club training sessions in other sports of their choice (6 hours). Due to the simplicity of application and relative objectivity of the interpretation of the results, the biological age of students was determined by the method of V. P. Voitenko, using the following formula [2]:

 $BA = 27.0 + 0.22 \times BP_s - 0.15 \times IHB + 0.72 \times SHS - 0.15 \times SB$, where BA - biological age, years, BP_s - systolic blood pressure, mm Hg, IHB - inspiratory holding of the breath, s, SHS - self-assessment of health status, points, SB - static balancing, s.

To assess the rate of aging of the students' bodies, it is necessary to compare the individual values of the actual biological age (BA) and the passport age (PA), which characterizes the average population standard of age-related "wear and tear". At the beginning and the end of the academic year, students' BA was diagnosed by the following indicators (biomarkers): systolic blood pressure (BP, mm Hg), inspiratory holding of the breath (IHB, s), index of self-assessment of health status (SHS) according to the special guestionnaire (29 questions, points, number of negative answers), time of static balancing (SB, s). At the beginning of the formative stage of the experiment, the homogeneity of all the EG and the CG indicators was determined (p > 0.05), and it was found that the distributions of the EG and the CG were normal, which allowed us to assess the reliability of the results using the Student's t-test. All indicators are presented as M ± m, where M is the arithmetic mean, and m is the error of the mean. The process of the research implementation was built following the requirements of scientific ethics. The research was approved by the Academic Ethics Commission of Ukrainian State Dragomanov University. The pedagogical experiment was open, its participants were informed about the aim of the research and voluntarily participated in it.

RESULTS

The average PA of students is 18.2 years (Table 1). The youngest student's BA is 23.5 years, which is 5 years higher than their PA; in all other ca1es, the indicators of students' BA are much worse.

The degree to which the BA exceeds the PA is presented in Table 2.

The rate of body aging was estimated by the difference between the BA and the PA (Table 3).

Table 1. Biological and passport age of 18-19-year-old students under study (n = 120)

| Indicators | PA, years | BA, years | Difference, years | Difference, % |
|------------|-------------|-------------|-------------------|-------------------|
| M ± m | 18.2 ± 1.15 | 44.8 ± 6.72 | 26.6 ± 5.57 | 142.8 ± 45.64 |

Table 2. The degree to which the biological age of 18-19-year-old students exceeds their passport age (n = 120)

| Excess amount, % | Number of students (%) |
|---|-------------------------|
| by 100 % (or twice) | 25 (21 %) |
| from 100 to 150 % (from 2 to 2.5 times) | 43 (36 %) |
| from 151 to 200 % (from 2.5 to 3 times) | 34 (28 %) |
| from 201 to 222 % (more than 3 times) | 18 (15 %) |
| | |

Table 3. Correlation of the biological and the passport age and assessment of aging rates of 18-19-year-old students (n = 120)

| Difference, years | The rate of aging | Number of students, (%) | |
|--------------------|---------------------|-------------------------|--|
| from –15 to – 9 | sharply slowed down | 0 (%) | |
| from – 8.9 to – 3 | slowed down | 3 (3 %) | |
| from – 2.9 to +2.9 | BA = PA | 5 (4 %) | |
| from +3 to +8.9 | accelerated | 11 (9 %) | |
| from +9 to +15 | sharply accelerated | 101 (84 %) | |

Table 4. Correlation between the biological and the passport age of 18-19-year-old students in the conditions of the formative stage of the pedagogical experiment ($M \pm m$, n = 60)

| Indicators | Groups | Before the experiment | After the experiment | % increase in the indicators | Reliability |
|---|--------|-----------------------|----------------------|---------------------------------|-----------------|
| PA | EG | 18.1 ± 1.1 | 19.2 ± 1.1 | 5.6 | p > 0.05 |
| | CG | 18.2 ± 1.15 | 19.2 ± 1.15 | 5.3 | p > 0.05 |
| ВА | EG | 44.3 ± 5.72 | 38.1 ± 2.72 | -15.1 | p ≤ 0.05 |
| | CG | 44.8 ± 6.72 | 43.8 ± 2.1 | -2.6 | p > 0.05 |
| Difference between the PA and the BA, years | EG | 26.2 ± 4.62 | 18.9 ± 5.57 | -32.4 | p ≤ 0.05 |
| | CG | 26.6 ± 5.57 | 24.6 ± 5.57 | -7.8 | p > 0.05 |

Table 5. Dynamics of individual biomarkers for assessing the biological age of 18-19-year-old students in the conditions of the formative stage of the pedagogical experiment ($M \pm m$, n = 60)

| Indicators | Groups | Before the experiment | After the experiment | % increase in the indicators | Reliability |
|-------------|--------|-----------------------|----------------------|---------------------------------|-------------|
| BP, mm Hg. | EG | 116.5 ± 4.5 | 117.0 ± 3.5 | 0.4 | p > 0.05 |
| | CG | 117.5 ± 4.5 | 117.5 ± 3.5 | 0 | p > 0.05 |
| IHB, s | EG | 70.0 ± 2.2 | 78.6 ± 2.3 | 11.6 | p ≤ 0.05 |
| | CG | 71.0 ± 1.8 | 69.5 ± 2.0 | -2.1 | p > 0.05 |
| SHS, points | EG | 19.5 ± 1.5 | 13.2 ± 2.3 | -38.5 | p ≤ 0.05 |
| | CG | 18.3 ± 1.5 | 17.5 ± 1.5 | -4.5 | p > 0.05 |
| SB, s | EG | 10.89 ± 0.53 | 13.31 ± 0.28 | 20.0 | p ≤ 0.05 |
| | CG | 10.77 ± 0.43 | 11.75 ± 0.43 | 8.7 | p ≤ 0.05 |

The motor experience of students was taken into account when developing the content of the educational material for martial arts training sessions. The success of competitive activities during martial arts training is influenced by loads of speed and strength orientation, which involve the performance of short-term and longterm work. The experience of the best practice recognizes that the development of the strength of the muscular corset, legs, and arms is the basis of strength training in martial arts. The main methods of developing students' strength abilities are repetitive (or repetitive-serial) and circuit training with the use of non-limited weights. It is expedient to apply game and competitive methods for the development of speed and strength qualities. In this case, it is worth using games and relays with elements of jumping, climbing, throwing, weight transfer, etc., as well as competitive fights. The method of circuit training in speed and strength preparation of students in martial arts training sessions provides a complex action on different muscle groups with the use of exercises with non-limited weights, which are performed in a circle of 4-6 "stations" (the place of performance of the given exercises) with a certain number of repetitions for a certain unit of time and rest (transition between "stations") at least 2-3 minutes, during which exercises on muscles relaxation are performed. The number of repetitions and approaches is determined depending on the size of the weight (the larger the weight, the fewer repetitions of the exercise and approaches), as well as the individual capabilities of students. During active rest between motor loads, young men performed exercises on stretching, increasing mobility in joints, and relaxation of muscles. In the dynamics of training sessions, it is necessary to periodically change the amount of additional weight, and increase the number of repetitions or approaches in a series of strength exercises.

Since the components of speed abilities are independent of each other, they can be developed both separately and comprehensively. The main methods of speed development are repetitive-serial, game, and competitive. The means are technically simple exercises of maximum intensity lasting 6-10 s, performed in 3-4 approaches with an interval of rest until complete recovery (100 ± 10 beats/ min or 1.5-2 minutes). The development of speed and its components is planned under the condition of optimal working capacity of students, that is, at the beginning of training sessions. However, despite the necessity to take into account the specifics of martial arts, the health-promoting orientation is the leading approach in the construction of the content of training sessions with students. The content of realization of health-promoting tasks in the process of martial arts training consists of the prevention of diseases and injuries, the increase of functional capabilities of an organism, and the versatile and harmonious development of motor qualities in students.

Thus, the reduction of 18-19-year-old students' BA in the process of using loads of speed and strength orientation during martial arts training sessions is provided by the realization of health-promoting tasks of physical education aimed at increasing functional capabilities of an organism, development of motor qualities, prevention of disorders in work of organs and systems of an organism and traumatism.

Evaluation of the CG and the EG students' BA at the beginning and the end of the academic year showed a decrease in the difference between the BA and the PA, but these changes were unreliable in the CG students (p > 0.05), while a statistically significant decrease in the

BA was recorded in the CG students ($p \le 0.05$) (Table 4). At the same time, the difference between the PA and the BA significantly decreased in the EG students who were engaged in martial arts and amounted to -32.4 % ($p \le 0.05$). As for the CG students, at the end of the academic year, the changes in the difference between the PA and BA were unreliable (p > 0.05).

Regarding the dynamics of indicators (individual biomarkers) characterizing the BA, the EG students showed some positive and significant changes ($p \le 0.05$) (Table 5).

Thus, significant ($p \le 0.05$) changes in the EG can be seen in the indicators of inspiratory breath holding (an increase of 11.6 %), subjective health assessment (an increase of -38.5 %), and static balancing (an increase of 20.0 %). As for the CG students who were engaged in the traditional program of physical education and other sports in the conditions of sports club activities, there is no significant improvement of individual biomarkers of organism development characterizing their BA (p > 0.05), except for the indicator of static balancing (an increase of 8.7 %, $p \le 0.05$). Thus, a significant improvement in some indicators of students' BA who were engaged in martial arts with an emphasis on the load of speed and strength orientation in the conditions of sports club activities was established.

DISCUSSION

The actualization of research on the problem of biological age and the rate of aging of the body in recent years is due to the decline in the indicators of the state of health of the population. Several researchers believe that the biological maturity of children and youth has real prognostic value for differentiating motor loads in physical education training sessions. Studies by specialists prove that biological age reflects the ontogenetic maturity of a person, gives an idea of working capacity, functional capabilities, and adaptation reserves, is a prognostic sign of motor talent for selection and orientation in certain sports, and also indirectly characterizes the level of health of an individual [12, 13].

At the same time, practice shows that the biological age of young people is significantly ahead of the passport age, indicating accelerated rates of aging and the dynamics of health deterioration. Given that the physiological, functional, and adaptive capabilities and reserves of the body affect the ratio of biological and passport age and determine the rate of aging of an individual, rationally organized motor activities should be considered the optimal anti-aging means [14].

The results of our research confirm the opinion of scientists [5, 12] that the correlation between biological and passport age describes the degree of loss of general health and vitality

of the body. At the same time, biological age is an indicator of the level of wear and tear of the structure and functions of the body and the organism as a whole, expressed in units of time and characterized by the ratio of the indicators of actual individual biomarkers to their average population values.

Our research is consistent with the results of other authors [2, 6, 8, 9], who argue that the study of students' biological age will help determine the impact of the optimal type and level of motor loads on the body to slow down the rate of age-related changes. Thus, the impact of specific motor loads on individual biomarkers of the body in particular and the rate of age-related changes in students, in general, contributes to a decrease in biological age and slows down the rate of age-related changes.

When using exercises of speed and strength orientation in the process of martial arts training in the conditions of sports club activities, it is necessary to be guided by the fact that the complexity of movements and parameters of loads should be feasible, then they give a health-promoting effect, exercises should be interesting and diverse, then they will cause positive emotions. Otherwise, low motor loads do not cause the desired effect, while excessive loads hurt somatic and mental health indicators, as they cause muscle and functional discomfort and negative emotions. The visible training and health-promoting effect of physical exercises causes a positive emotional effect [10, 15].

As a result of the research, it was confirmed that the use of motor exercises of speed and strength orientation in the process of martial arts training in the conditions of sports club activities positively influences the improvement of results of static balancing, breath holding, and subjective assessment of health [16, 17]. All this testifies to a more pronounced health-promoting effect of physical exercises of speed and strength orientation during martial arts training sessions and the advantages of their use for reducing the intensity of aging of the student youth.

CONCLUSIONS

1. It has been established that, given the steady trend toward the deterioration of public health, the priority task of physical education in higher educational institutions is the improvement of student health. At the same time, one of the ways to improve the effectiveness of physical education of students is the use of speed and strength loads in various forms of organization of loads, which are characteristic of martial arts.

- 2. The methodology for applying different types of martial arts in the conditions of sports clubs, which includes the content, means, methods, and forms of realization of educational, didactic, and health-promoting tasks, has been substantiated and developed. The methodology is based on the use of loads of speed and strength orientation in the course of martial arts training sessions.
- 3. The use of physical loads of speed and strength orientation in the course of martial arts training sessions has a health-promoting effect and positively influences the optimization of an organism' biomarkers values and reduction of intensity of "wear and tear" of an organism of student youth. Thus, in the dynamics of the experiment, there is a tendency to a decrease in the difference between the biological and the passport age, but these changes are unreliable in the CG students (p > 0.05), while a statistically significant decrease in this difference in the EG students who were engaged in martial arts ($p \le 0.05$) was recorded. In addition, in the EG, we can talk about significant changes in some individual biomarkers of the body: indicators of inspiratory breath holding (an increase of 11.6%, at $p \le 0.05$), indicators of subjective health assessment (an increase of the self-assessment questionnaire scores of -38.5 %, at $p \le 0.05$), indicators of static balancing (an increase of 20.0 %, at $p \le 0.05$) in the students who were engaged in martial arts with the use of loads of speed and strength orientation. In the CG students there is a significant improvement only in the indicators of static balancing (an increase of 8.7%, at $p \le 0.05$). The results of the research can be implemented in physical education training sessions and the process of sports and pedagogical improvement of students in higher educational institutions.

Prospects for further research will be aimed at studying the impact of training sessions in various types of martial arts on the intensity of aging of the body of female students.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Natalia A. Lyakhova

Poltava State Medical University 24 Shevchenko st., 36000 Poltava, Ukraine e-mail: natanew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP

Oleksii V. Tymoshenko: 0000-0002-5310-4941 Zhanna H. Domina: 0000-0002-8315-6590 Valentyna H. Bilyk: 0000-0002-6860-7728 Yurii P. Serhiienko: 0000-0003-1019-6513 Oleksandr M. Lavrentiev: 0000-0002-6960-0237 Nataliia A. Dakal: 0000-0002-7030-5112 Petro S. Horhol: 0009-0005-1738-7023 F

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ORIGINAL ARTICLE

CONTENTS 🔼

Dynamics of health and physical development indicators of cadets during their professional training in the field environment

Kostiantyn V. Prontenko¹, Stanislav O. Yuriev², Yurii G. Babaiev², Oleh O. Zimnikov², Taras H. Shchur², Oleh O. Abramenko², Oleksandr Yu. Borzilo²

¹S.P. KOROLIOV ZHYTOMYR MILITARY INSTITUTE, ZHYTOMYR, UKRAINE

²MILITARY INSTITUTE OF TANK TROOPS OF THE NATIONAL TECHNICAL UNIVERSITY "KHARKIV POLYTECHNIC INSTITUTE", KHARKIV, UKRAINE

ABSTRACT

Aim: To investigate the dynamics of health and physical development indicators of cadets during their field training exercises of various durations.

Materials and Methods: The research involved 246 cadets (men) of the 1st-4th training years, who were majoring in the specialty 253 referred to as "Military Management" (specialization "Management of Tank Troops"). The research was conducted in 2022-2023 during field training exercises lasting 2 and 4 weeks. Research methods: theoretical analysis and synthesis of literature, medical and biological methods, testing, statistical analysis.

Results: It was found that the level of health and physical development of cadets deteriorates during their field training exercises. The worst level among the studied indicators after the cadets' field training exercises was recorded in the indicators of vital index, Robinson index, and endurance level. It was found that the longer the duration of field training exercises, the more the health and physical development of cadets deteriorates. The most pronounced deterioration in the level of the studied indicators was found in the cadets of junior training years.

Conclusions: The deterioration of cadets' health and physical development during their field training exercises has been proven. The most negative changes occurred in the indicators of the cadets' cardiorespiratory system. The results indicate the need to improve the organization and methods of physical training with cadets during field training exercises, which will help maintain their health and physical development at the proper level.

KEY WORDS: health, physical development, physical training, field training, cadets

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INTRODUCTION

The Russian-Ukrainian war, which began in 2014, has led to an increase in the practical component of training cadets of higher military educational institutions (HMEIs) of all military specialties [1, 2]. In the educational process of HMEIs, this was reflected in a significant increase in the volume of field exercises (field training exercises) aimed at: acquiring and improving cadets' practical skills in working with weapons and military equipment within their specialty; formation of general, professional (military-professional, military-specialized) competencies defined by the standards of higher education in the specialty, professional standards for the relevant degrees of higher education and levels of military education; ensuring quality of the general military training of future cadets; practicing issues of units management and organization of interaction; practicing cadets' actions during practical firing from various types of weapons and equipment; achieving

a high level of field training, unit cohesion, as well as physical and psychological readiness of personnel to perform combat missions [3, 4].

The most pronounced increase in the volume of practical training occurred in the educational process of the cadets at the HMEI of the Ground Forces (GF) of the Armed Forces (AF) of Ukraine. At the same time, observations of cadets' health and level of physical fitness (physical development) after returning from field training exercises indicate a significant deterioration. Herewith, the magnitude of changes in these indicators depends on the year of training and the duration of field training exercises. This does not allow us to fully achieve the goal of physical education of future specialists of the tank troops of the Armed Forces of Ukraine during their studies at HMEIs, namely, ensuring their physical readiness for professional activities [5, 6]. At the same time, physical readiness is determined by graduates' physical condition at HMEIs, which allows them to

perform combat and other assigned tasks following the requirements of modern combat [7].

AIM

The aim is to investigate the dynamics of health and physical development indicators of cadets during their field training exercises of various durations.

MATERIALS AND METHODS

The research involved male cadets of the Military Institute of Tank Troops of the National Technical University "Kharkiv Polytechnic Institute" (n = 246) of the 1st-4th training years, who were majoring in the specialty 253 referred to as "Military Management" (specialization "Management of Tank Troops"). The research involved 62 1st training year cadets, 64 2nd training year cadets, 59 3rd training year cadets, and 61 4th training year cadets. The research was conducted in 2022-2023 during field training exercises in the fall (September-October) and spring (April-June) periods. The duration of the field training exercises was 2 weeks in the fall and 4 weeks in the spring.

Research methods: theoretical analysis and synthesis of literature, medical and biological methods, testing, statistical analysis. Theoretical analysis and synthesis of literature were used to find out the current state of the researched problem, systematize and generalize information to achieve the aim of the article (14 sources on the topic of the article from the databases PubMed, Scopus, Web of Science Core Collection, Index Copernicus and others were investigated). Medical and biological methods were used to study health indicators of cadets. Cadets' health was assessed by the following indicators: body mass index (BMI, kg/m²), vital index (VI, ml/kg), the Robinson index (RI, c. u.). Cadets' physical development was determined by the results of their testing in exercises that characterize different motor qualities: speed qualities - 100 m run, strength qualities – pull-ups, endurance – 3 km run.

The significance of the difference in the results of the cadets was determined during the studying based on the Student's t-test. The significance for all statistical tests was set at p<0.05. All statistical analyses were performed with the SPSS software, version 21, adapted to medical and biological researches. This research followed the regulations of the World Medical Association Declaration of Helsinki. Also this research complies with the ethical standards of the Order of the Minister of Defense of Ukraine "On Approval of the Regulation on the Organization of Scientific and Technical Activity in the Armed Forces of Ukraine" No. 385 dated 27.07.2016.

Informed consent was received from all cadets who took part in this research.

RESULTS

The analysis of BMI, which was determined by the ratio of body weight to double height, showed that its value decreased insignificantly (p > 0.05) during the period of field training exercises for the cadets of all training years (Table 1). At the same time, the difference between the BMI before and after the field training exercise was greater in junior cadets compared to senior ones. In addition, it was found that after a field training exercise for 4 weeks, the BMI indicators underwent greater changes in the cadets of all training years than after a two-week field training exercise. Changes in BMI are due to a decrease in body weight in cadets of all training years because of intensive practical training in the field and an increase in the volume of their motor activities.

The analysis of VI showed some deterioration of this indicator in the cadets of all training years during their field training exercises (Table 2), but the deterioration became more pronounced with the increase in the duration of the field training exercise. In addition, for junior cadets, the difference between the indicators of the VI before and after field training exercises was greater than for senior cadets. The deterioration of the cadets' VI during field training exercises is due to a decrease in the vital capacity of the lungs and the detraining of the respiratory system in cadets.

The analysis of RI showed that, as in the case of VI, there was a deterioration in the performance of the cardiovascular system in the cadets of all training years (Table 3). However, this trend was more pronounced in junior cadets than in senior cadets. Moreover, as the duration of the field training exercise increased, the difference between the RI indicators before and after the field training exercise increased. This indicates that long-duration field training exercises hurt both the activity of the respiratory system of the cadets' body and the cardiovascular system.

The analysis of the development of speed qualities during the field training exercise lasting 2 weeks showed that the indicators deteriorated by 0.04-0.12 s in all training years, but no significant difference between the results before and after the field training exercise was found (p > 0.05) (Table 4). The greatest deterioration in the development of high-speed qualities was found in the 1st training year cadets (0.12 s). Comparison of the indicators before and after the field training exercise lasting 4 weeks testified to more expressed negative changes in the level of development of high-speed qualities of cadets of all training years, in comparison

| | 5 | 5 | | | | | | |
|---|----|-------------------------|---------------------|--------------------------------|-------------|--|--|--|
| Veer of training | _ | Before the field | After the field | Significance of the difference | | | | |
| rear of training | n | training exercise | training exercise | Difference | t; p | | | |
| | TI | ne field training exerc | ise lasting 2 weeks | | | | | |
| 1 st | 62 | 23.17±0.14 | 23.08±0.12 | 0.09 | 0.49; >0.05 | | | |
| 2 nd | 64 | 23.68±0.11 | 23.61±0.10 | 0.07 | 0.47; >0.05 | | | |
| 3 rd | 59 | 24.06±0.15 | 24.01±0.14 | 0.05 | 0.24; >0.05 | | | |
| 4 th | 61 | 24.32±0.13 | 24.29±0.12 | 0.03 | 0.17; >0.05 | | | |
| The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 23.34±0.13 | 23.21±0.11 | 0.13 | 0.76; >0.05 | | | |
| 2 nd | 64 | 23.82±0.12 | 23.73±0.11 | 0.09 | 0.55; >0.05 | | | |
| 3 rd | 59 | 24.25±0.16 | 24.18±0.14 | 0.07 | 0.33; >0.05 | | | |
| 4 th | 61 | 24.47±0.15 | 24.42±0.15 | 0.05 | 0.24; >0.05 | | | |

| Table 1. BMI dynamics in cadets during their field training exercises of different durations (| M±m | , n=246 | kg/m ² |) |
|--|-----|---------|-------------------|---|
|--|-----|---------|-------------------|---|

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of cadets; t – t-test value; p – significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

|--|

| Voor of training | Before the field | | After the field | Significance of the difference | | | | |
|---|------------------|-------------------------|---------------------|--------------------------------|-------------|--|--|--|
| rear of training | n | training exercise | training exercise | Difference | t; p | | | |
| | T | he field training exerc | ise lasting 2 weeks | | | | | |
| 1 st | 62 | 55.89±0.64 | 55.48±0.66 | 0.41 | 0.45; >0.05 | | | |
| 2 nd | 64 | 56.14±0.61 | 55.76±0.64 | 0.38 | 0.43; >0.05 | | | |
| 3 rd | 59 | 56.32±0.65 | 56.05±0.67 | 0.27 | 0.29; >0.05 | | | |
| 4 th | 61 | 56.61±0.58 | 56.43±0.60 | 0.18 | 0.21; >0.05 | | | |
| The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 56.03±0.59 | 55.11±0.57 | 0.92 | 1.12; >0.05 | | | |
| 2 nd | 64 | 56.20±0.57 | 55.37±0.55 | 0.83 | 1.05; >0.05 | | | |
| 3 rd | 59 | 56.39±0.60 | 55.93±0.60 | 0.46 | 0.54; >0.05 | | | |
| 4 th | 61 | 56.72±0.55 | 56.24±0.54 | 0.48 | 0.62; >0.05 | | | |

Note: M — arithmetic mean; m — error of arithmetic mean; n — number of cadets; t — t-test value; p — significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

with the field training exercise for 2 weeks. The difference was 0.08 s in the 4th training year and 0.22 s in the 1st training year, but it was unreliable in all training years (p > 0.05).

The study of the dynamics of results in pull-ups showed that the level of strength qualities development, as well as speed qualities, in the cadets of all training years, deteriorated during field training exercises. At the same time, the longer the duration of the field training exercise, the more pronounced was the deterioration in results. Thus, after returning from the field training exercise lasting 2 weeks, the cadets' results deteriorated by 0.7 times in the 1st training year; by 0.5 times in the 2nd and 3rd training years; and by 0.4 times in the 4th training year. After the 4-week field training exercise, the difference between the results before and after the field training years and to 0.8 times in the 1st and 2nd training years and to 0.8 times in the

senior training year (Table 5). However, there was no significant difference between the indicators before and after the field training exercise both for 2 and 4 weeks (p > 0.05).

The analysis of the results in the 3 km run showed that the level of endurance development in the cadets of all training years deteriorated the most among the physical qualities studied, both after the two-week field training exercise and after the four-week field training exercise. Thus, after the field training exercise lasting 2 weeks, the results in the 3 km run deteriorated by 24.5-19.3 s (depending on the training year), after the field training exercise lasting 4 weeks – by 24.8-30.6 s, respectively (Table 6). At the same time, the difference in the indicators of endurance development before and after the field training exercises of different durations was reliable in the cadets of most training years (p < 0.05).

It should be noted that the greatest deterioration in

| Veen of tweining | | Before the field | After the field | Significance of the difference | | | | |
|---|----|--------------------------|---------------------|--------------------------------|-------------|--|--|--|
| Year of training | n | training exercise | training exercise | Difference | t; p | | | |
| | ٦ | The field training exerc | ise lasting 2 weeks | | | | | |
| 1 st | 62 | 88.03±0.59 | 88.67±0.60 | 0.64 | 0.76; >0.05 | | | |
| 2 nd | 64 | 87.46±0.56 | 87.88±0.58 | 0.42 | 0.52; >0.05 | | | |
| 3 rd | 59 | 86.78±0.58 | 87.06±0.59 | 0.28 | 0.34; >0.05 | | | |
| 4 th | 61 | 84.97±0.60 | 85.25±0.61 | 0.28 | 0.33; >0.05 | | | |
| The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 87.56±0.57 | 88.71±0.59 | 1.15 | 1.40; >0.05 | | | |
| 2 nd | 64 | 86.89±0.55 | 87.90±0.57 | 1.01 | 1.28; >0.05 | | | |
| 3 rd | 59 | 86.24±0.56 | 87.13±0.57 | 0.89 | 1.11; >0.05 | | | |
| 4 th | 61 | 84.21±0.58 | 85.08±0.60 | 0.87 | 1.04; >0.05 | | | |

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|---|---------------------------------------|------------------------|----------------------------------|--------------------------|
|---|---------------------------------------|------------------------|----------------------------------|--------------------------|

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of cadets; t – t-test value; p – significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

| Table 4. The dynar | nics of cadets' speed | qualities developm | ent during their | field training exercises of | f different durations (N | ∕l±m, n=246, s) |
|--------------------|-----------------------|--------------------|------------------|-----------------------------|--------------------------|-----------------|
| | | | 5 | 5 | | |

| Very of two in in a | Before the fiel | | After the field | Significance of the difference | | | | | |
|---------------------|---|--------------------------|---------------------|--------------------------------|-------------|--|--|--|--|
| fear of training | n | training exercise | training exercise | Difference | t; p | | | | |
| | 1 | The field training exerc | ise lasting 2 weeks | | | | | | |
| 1 st | 62 | 13.78±0.12 | 13.97±0.13 | 0.12 | 1.03; >0.05 | | | | |
| 2 nd | 64 | 13.34±0.10 | 13.42±0.12 | 0.08 | 0.51; >0.05 | | | | |
| 3 rd | 59 | 13.05±0.09 | 13.11±0.10 | 0.06 | 0.45; >0.05 | | | | |
| 4 th | 61 | 12.75±0.08 | 12.80±0.09 | 0.05 | 0.42; >0.05 | | | | |
| | The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 13.56±0.11 | 13.78±0.12 | 0.22 | 1.35; >0.05 | | | | |
| 2 nd | 64 | 13.25±0.09 | 13.39±0.11 | 0.14 | 0.99; >0.05 | | | | |
| 3 rd | 59 | 13.09±0.09 | 13.22±0.11 | 0.12 | 0.91; >0.05 | | | | |
| 4 th | 61 | 12.87±0.08 | 12.95±0.10 | 0.08 | 0.62; >0.05 | | | | |

Note: M — arithmetic mean; m — error of arithmetic mean; n — number of cadets; t — t-test value; p — significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

the level of endurance development, as well as other physical qualities, was found in junior cadets. This is due to insufficient adaptation of their body to the conditions of educational activities, instability of motor skills and capabilities, and inability to independently maintain the level of development of their physical qualities at the achieved level in the field environment. The results obtained indicate the need to find effective forms, methods, and means of physical training that would ensure the solution of this problem during field training exercises.

DISCUSSION

Modern combat operations, which take place in extreme environmental conditions, are an extremely difficult test of the physical strength to the military personnel of the Armed Forces of Ukraine. Combat activities, accompanied by significant physical and psychological stress, increasing fatigue, and the negative impact of other adverse factors, place high demands on both the physical readiness of military personnel and the level of their morphological and functional development and health [8, 9]. Physical readiness, as a physical condition of military personnel that allows them to perform combat and other assigned tasks following the requirements of modern combat, is the main goal of physical training and is formed in the process of systematic physical exercises [10, 11].

Scientists note that physical training is the basis of a high level of combat readiness of service members for combat activities [12, 13]. At the same time, in the process of field training exercises, cadets experience a deterioration in both health and physical development indicators and their physical fitness, which leads to a decrease in their physical readiness for professional and

| Voor of training | | Before the field | After the field | Significance of the difference | | | | |
|---|----|--------------------------|----------------------|--------------------------------|-------------|--|--|--|
| fear of training | n | training exercise | training exercise | Difference | t; p | | | |
| | | The field training exerc | cise lasting 2 weeks | | | | | |
| 1 st | 62 | 13.6±0.56 | 12.9±0.63 | 0.7 | 0.83; >0.05 | | | |
| 2 nd | 64 | 15.8±0.49 | 15.3±0.52 | 0.5 | 0.70; >0.05 | | | |
| 3 rd | 59 | 16.4±0.46 | 15.9±0.48 | 0.5 | 0.75; >0.05 | | | |
| 4 th | 61 | 16.8±0.48 | 16.4±0.49 | 0.4 | 0.58; >0.05 | | | |
| The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 14.1±0.51 | 13.2±0.55 | 0.9 | 1.20; >0.05 | | | |
| 2 nd | 64 | 16.0±0.43 | 15.1±0.45 | 0.9 | 1.45; >0.05 | | | |
| 3 rd | 59 | 16.6±0.40 | 15.8±0.44 | 0.8 | 1.35; >0.05 | | | |
| 4 th | 61 | 16.9±0.38 | 16.1±0.42 | 0.8 | 1.41; >0.05 | | | |

| Table 5. The dynam | ics of cadets' strength | n qualities develop | oment during | their field training | g exercises of different durations | (M±m, n= | =246, times) |
|--------------------|-------------------------|---------------------|--------------|----------------------|------------------------------------|----------|--------------|
|--------------------|-------------------------|---------------------|--------------|----------------------|------------------------------------|----------|--------------|

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of cadets; t – t-test value; p – significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

| Table 6. The dynami | ics of cadets' endurance develo | pment during their field training | g exercises of different durations / | $(M \pm m, n = 246, s)$ |
|---------------------|---------------------------------|-----------------------------------|--------------------------------------|-------------------------|
| | | | | . , , , , |

| Very of two in in a | Before the field | | After the field | Significance of the difference | | | | | |
|---------------------|---|--------------------------|---------------------|--------------------------------|-------------|--|--|--|--|
| fear of training | n | training exercise | training exercise | Difference | t; p | | | | |
| | - | The field training exerc | ise lasting 2 weeks | | | | | | |
| 1 st | 62 | 743.3±7.79 | 767.8±8.52 | 24.5 | 2.12; <0.05 | | | | |
| 2 nd | 64 | 729.1±7.52 | 751.4±8.07 | 22.3 | 2.02; <0.05 | | | | |
| 3 rd | 59 | 701.4±6.91 | 720.7±7.61 | 19.3 | 1.86; >0.05 | | | | |
| 4 th | 61 | 690.5±6.83 | 710.9±7.39 | 20.4 | 2.03; <0.05 | | | | |
| | The field training exercise lasting 4 weeks | | | | | | | | |
| 1 st | 62 | 747.5±7.63 | 778.1±8.40 | 30.6 | 2.70; <0.05 | | | | |
| 2 nd | 64 | 731.3±7.41 | 759.7±7.94 | 28.4 | 2.61; <0.05 | | | | |
| 3 rd | 59 | 709.8±6.98 | 735.2±7.55 | 25.4 | 2.47; <0.05 | | | | |
| 4 th | 61 | 696.2±6.95 | 721.0±7.28 | 24.8 | 2.46; <0.05 | | | | |

Note: M – arithmetic mean; m – error of arithmetic mean; n – number of cadets; t – t-test value; p – significance of difference between the indicators of cadets before and after the field training exercise due to the t-test.

combat activities. The reasons for the deterioration of cadets' health and physical development during field training exercises include the absence of practical training sessions in the academic subject area referred to as "Physical Education, Special Physical Training" as the main form of physical education during field training exercises; large volumes of cadets' motor activities during practical training on weapons and military equipment; low level of cadets' motivation to perform physical exercises in the process of concurrent physical training; lack of material resources for physical training in the field environment and proper conditions for training; insufficient knowledge, skills and abilities of cadet unit commanders to conduct physical training sessions with personnel in the field environment.

The problem of improving the physical training of service members of the Armed Forces of Ukraine and cadets of HMEIs of various specialties of the Armed Forc-

es has been the subject of scientific research by many scientists [4, 7, 12, 14]. However, the issue of maintaining the health and physical development of cadets at the achieved level during field training exercises remains insufficiently addressed. It is also necessary to develop practical recommendations for commanders of cadet units on conducting physical training sessions with personnel in the field environment, depending on the year of cadets' training and the duration of field training exercises.

CONCLUSIONS

It was found that during field training exercises of different durations, the level of health and physical development in the cadets of all training years deteriorates. The worst level among the studied indicators after the cadets' return from the field training exercises was recorded in VI, RI, and the level of endurance development. All these indicators showed a deterioration in the functional capabilities of the cadets' cardiorespiratory system. At the same time, it was found that the longer the duration of field training exercises, the more the level of health and physical development of cadets deteriorated. The most pronounced deterioration in the level of the studied indicators was found in junior cadets. The results indicate the need to improve the organization and methods of physical training with cadets during field training exercises, which will help maintain their health and physical development at the proper level.

THE PROSPECT OF FURTHER RESEARCH

It is planned to investigate the motivation of cadets to exercise in the field environment.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Kostiantyn V. Prontenko

S.P. Koroliov Zhytomyr Military Institute 22 Myru Avenue, 10004 Zhytomyr, Ukraine e-mail: prontenko-kostya@ukr.net

ORCID AND CONTRIBUTIONSHIP

Kostiantyn V. Prontenko: 0000-0002-0588-8753 (*) Stanislav O. Yuriev: 0000-0002-9498-4316 (*) Yurii G. Babaiev: 0000-0003-0749-5088 (*) Oleh O. Zimnikov: 0000-0001-5015-5455 (*) Taras H. Shchur: 0009-0008-5383-1648 (*) Oleh O. Abramenko: 0000-0003-3479-7479 (*) Oleksandr Yu. Borzilo: 0009-0007-7698-1107 (*) (*)

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Professional health of instructor-officers with different service experience

Ivan M. Okhrimenko¹, Olga G. Marchenko², Olena Yu. Sashurina², Olha M. Pasko³, Liudmyla M. Prudka³, Tetyana V. Matiienko³, Inha A. Serednytska³

¹NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE ²KHARKIV NATIONAL UNIVERSITY OF INTERNAL AFFAIRS, KHARKIV, UKRAINE ³ODESA STATE UNIVERSITY OF INTERNAL AFFAIRS, ODESA, UKRAINE

ABSTRACT

Aim: To investigate the levels and indicators of professional deformation in instructor-officers with different service experience as a negative factor in their professional health.

Materials and Methods: The research, which was conducted in 2022-2023, involved 136 instructor-officers of the National Academy of Internal Affairs aged 25-55 years with different service experience (up to 5 years – 21 people, 5-10 years – 45 people, 10-15 years – 42 people, over 15 years – 28 people). **Results:** The dynamics of the levels of professional deformation in instructor-officers of higher educational institutions depending on the experience of their service activities have been determined, and the peculiarities of the manifestation of key professional and psychological indicators that affect their professional health in the course of their service activities have been revealed.

Conclusions: Professional deformation can be manifested at the initial, middle, and deep levels. The experience of service activities makes adjustments to the formation of professional deformation in instructor-officers because deformational changes in personality occur under the constant influence of the conditions of the profession. With the increase in experience, they become more adapted to stressful phenomena and tense situations of service activities, but the degree of desire to change the type of activity increases. The decrease in proactive attitude and selectivity of contacts during the performance of professional tasks is often accompanied by exhaustion, which indicates a progressive tendency to the development of deformational changes in instructor-officers.

KEY WORDS: professional health, professional deformation, instructor-officers, service activities

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INTRODUCTION

Health is one of the main prerequisites for the self-realization of a person, and his or her significant achievements in various activities, including professional activities. Concerning the performance of professional activities by a person, experts [1, 2] distinguish the concept of "professional health", which is characterized as an integral component of general health, combining all its main components. In the scientific literature, professional health is interpreted by scientists [3] as a complex characteristic of human health in specific conditions of professional activities, characterized by adaptation to the influence of factors of the professional environment, provided with a functional reserve of the body sufficient to perform a certain type of professional activities, manifested in the form of a state of physical, mental, social and spiritual well-being. Professional health is one of the factors of professional suitability, an important condition for performance, an indicator of the "quality" of professional life and professional longevity, and the ability to withstand the negative factors that accompany this activity [4, 5]. One of the negative factors of any professional activity is occupational deformation [6, 7]. The problem of professional deformation is especially acute for sociometric professions, which include instructor-officers of higher educational institutions with specific learning environment (HEIs with SLE). The service activities of instructor-officers are full of tense (stressful) situations, which contribute to their professional deformation [8-10]. Professional deformation is quite often the cause of the formal performance of functional duties and official powers [11, 12]. At the same time, there may be cases of development of certain deformational changes that are social and psychological and affect the health and longevity of specialists, becoming a significant obstacle to further service and

educational activities. First of all, stereotypes of behavior and negative habits appear, mechanisms of perception of work colleagues change, and communication with participants of educational relations becomes more difficult [13, 14]. However, under the influence of specific conditions of professional activities, not only the behavioral model of an instructor-officer but also psychological characteristics (signs of intellectual exhaustion, emotional burnout, etc.) can be subject to changes. These processes cause negative changes in the parameters of personal characteristics and professional health of instructor-officers, which significantly limits the possibility of realizing the potential of specialists and distorts the results of its implementation. Therefore, the study of the levels and indicators of professional deformation in instructor-officers is necessary for the early diagnosis of negative personal changes under the influence of service activities.

AIM

The aim is to investigate the levels and indicators of professional deformation in instructor-officers with different service experience as a negative factor in their professional health.

MATERIALS AND METHODS

The research, which was conducted in 2022-2023, involved 136 instructor-officers of the National Academy of Internal Affairs aged 25-55 years with different service experience (up to 5 years – group 1 (n = 21); 5-10 years – group 2 (n = 45); 10-15 years – group 3 (n = 42); more than 15 years – group 4 (n = 28)).

Research methods: theoretical analysis and generalization of literary sources, psycho-diagnostic testing, survey, statistical methods. Psycho-diagnostic testing was conducting according to the methodology for diagnosing professional deformation. This methodology allowed us to identify the initial, intermediate, and advanced levels of professional deformation in the individual. The respondents were asked to answer 30 statements related to their professional activities. Carefully reading each of them, the instructor-officers answered as follows: "almost never" - 0 points; "sometimes" - 1 point; "often" - 2 points; "always" - 3 points. The answers were recorded on a special form. The following calculations were made using the key: first, the sum of points scored on each of the 5 main deformation indicators was primarily determined (specific statement numbers corresponded to the number of the deformation indicator), then the total sum of points was calculated. The total number of points scored demonstrates the appropriate level (initial, intermediate, advanced) and stage (formation, development, consolidation) of professional deformation in instructor-officers.

The survey was conducted according to the author's questionnaire (10 questions), which contained two blocks for determining professional and psychological indicators of instructor-officers' deformation. Each question has four answer options ("never"; "sometimes"; "often"; "always"). All respondents had the opportunity to select one of the answer options. Each question in the questionnaire survey reflected a corresponding professional or psychological indicator of activities. For example, the question "Is your work full of stressful events?" reflects the indicator of "presence of stressful events" during educational activities; "Are you satisfied with the results of your work?" demonstrates the indicator of "satisfaction of respondents with their work", etc. We conducted the comparative analysis between the groups of respondents, the main criterion of which was the length of pedagogical experience of instructor-officers in higher educational institutions. We did not take into account the age characteristics of the respondents.

Statistical methods were used to systematize, process, qualitatively and quantitatively evaluate the data obtained, present the results in tabular forms, and formulate reliable conclusions. The results were expressed as percentages. This research followed the regulations of the World Medical Association Declaration of Helsinki and ethical principles for medical research involving human subjects. Informed consent was received from all respondents who took part in this research.

RESULTS

The results of the study of the levels of professional deformation in instructor-officers are shown in Fig. 1.

Group 1 includes instructor-officers who do not have significant deformational changes (61.9 %). They are at the stage of adaptation and are only adjusting to the conditions of their service activities. This group is characterized by active absorption of professional activities and dominance of professional orientation through the adoption of new standards of behavior. In groups 2 and 3, the average level of deformation is determinative (55.5 % and 57.1 %, respectively). These individuals have gone through a period of adaptation to their service activities by testing their ability to self-regulate their behavior and lifestyle; they have gained experience that facilitates the performance of professional tasks. During this period, instructor-officers already have certain negative manifestations, but they do not correlate with deformation. The instructor-officers of group 4 have significant indicators of a deep



Fig. 1. The correlation of levels of professional deformation in instructor-officers with different experience of service (n = 136), %.

level of professional deformation (42.9 %). This level radically changes the personality of a professional: the progression of negative behavioral patterns, the rooting of unfavorable qualities, and the confrontation between individual qualities in the psychological structure of the personality. The deformation takes the form of fanatical dedication to work, and more and more often there is a justification of oneself and one's standpoints.

The author's questionnaire for determining professional and psychological indicators of deformation in instructor-officers was used to establish the conditions for the emergence and development of deformation changes. The key standpoints to be studied included the definition of professional and psychological indicators of deformation manifested during the pedagogical activities of instructor-officers, namely: excessive tension; state of nervousness; presence of stressful phenomena; manifestations of proactive attitude during the performance of professional tasks; emotionality and empathy; rapport; exhaustion; job satisfaction; desire to change the line of work; desire to resign. The results are presented in Table 1 and Table 2.

Rapport dominates in Group 2 instructor-officers (46.7 % in the "often" option), which is quite natural, as these respondents have passed all stages of adaptation and can position themselves better in relationships. Instead, Group 1 is just going through the stages of entering the profession, so the level of their rapport is insignificant (23.8 %). In Groups 3 and 4, instructor-officers are gradually moving away from excessive and constant professional contacts (31.0 % and 21.4 % in the "often" option). They point out that they spend too much energy with this model of behavior, which is why such contacts are mostly situational.

Such indicators as the presence of stressful phenomena and proactive attitude are in a cause-and-effect relationship because stressful phenomena and situations can provoke excessive proactive attitude and additional efforts in the performance of professional tasks. Respondents with 5 years or more of educational experience have already learned to cope with their stress, compared to less experienced instructor-officers (the latter have the highest rates in the "often" and "always" options - 33.3% and 9.5%, respectively). A similar situation is observed in the indicator referred to as "proactive attitude to performing professional tasks". This means that more experienced instructor-officers have already managed to develop their model of behavior, and therefore do not show an excessive proactive attitude (in the "often" option, respondents with 10-15 and more than 15 years of experience show approximately the same indicators - 23.8 % and 21.4 %).

It was also found that instructor-officers of group 1 do not have a conscious desire to change their line of work (62.0 %), let alone resign (80.9 %). At the same time, instructor-officers with more years of service are increasingly thinking about changing their jobs (33.3 % of respondents in group 3, 42.9 % in group 4). It was found that excessive tension and nervousness are evident in instructor-officers of group 1 (often 42.9 % and 47.6 %, respectively). Over time, excessive tension and nervousness become less pronounced. These indicators in the "often" option are less typical for instructor-officers with more experience in the service activities: 5-10 years - 35.6 % and 37.8 %; 10-15 years - 31.0 % and 33.3 %; more than 15 years - 25.0 % and 21.4 %. Hence, it can be argued that the tension in instructor decreases as they master the profession and gain experience.

| Professional indicators of deformation | Frequency of manifestation | Groups of instructor-officers | | | | |
|---|----------------------------|-------------------------------|----------------|----------------|-------------------|--|
| | | Group 1 n = 21 | Group 2 n = 45 | Group 3 n = 42 | Group 4 n = 28 | |
| Presence of stressful phenomena | a | 14.3 | 20.0 | 28.6 | 46.5 | |
| | b | 42.9 | 42.2 | 38.1 | 28.5 | |
| | с | 33.3 | 28.9 | 21.4 | 14.3 | |
| | d | 9.5 | 8.9 | 11.9 | 10.7 | |
| Cooperativeness | а | 9.5 | 4.4 | 7.1 | 10.7 | |
| | b | 52.4 | 33.3 | 47.6 | 53.6 | |
| | с | 23.8 | 46.7 | 31.0 | 21.4 | |
| | d | 14.3 | 15.6 | 14.3 | 14.3 | |
| Proactive attitude during the performance of professional tasks | а | 4.8 | 8.9 | 9.5 | 14.3 | |
| | b | 28.6 | 37.7 | 52.3 | 53.6 | |
| | с | 47.6 | 35.6 | 23.8 | 21.4 | |
| | d | 19.0 | 17.8 | 14.3 | 10.7 | |
| Desire to change the type of activities | а | 62.0 | 35.6 | 21.4 | 17.9 | |
| | b | 19.0 | 37.7 | 40.5 | 28.5 | |
| | с | 9.5 | 15.6 | 23.8 | 35.7 | |
| | d | 9.5 | 11.1 | 14.3 | 17.9 | |
| Desire to leave the higher educational institution | а | 80.9 | 66.7 | 19.1 | 10.7 | |
| | b | 9.5 | 13.3 | 35.7 | 25.0 | |
| | с | 4.8 | 11.1 | 33.3 | 42.9 | |
| | d | 4.8 | 8.9 | 11.9 | 21.4 | |

Table 1. Correlation of professional indicators of deformation in instructor-officers as a negative factor of their professional health (n = 136), %

Legend: a – never; b – sometimes; c – often; d – always.

To some extent, a similar trend can be seen in the indicator of emotionality and empathy. While for instructor-officers with up to 5 years of experience, this indicator is quite stable (with 47.6 % in the "often" and 23.8 % in the "always" options). Young instructor-officers are more emotional and open in their relationships with colleagues and military students. At the same time, more experienced instructor-officers are quite reserved and more cautious in expressing their emotions. A significant number of respondents preferred the "sometimes" option (in group 2 - 44.4 %; in group 3 - 47.6 %; in group 4 - 42.8 %). This can be seen as a possibility of accumulation of negative emotions that will be carefully hidden, but sooner or later can provoke an "explosion" and strong internal agitation.

At the same time, the data show that the instructors of groups 3 and 4 are exhausted (often in group 3 - 33.3 %; in group 4 - 32.1 %). For comparison, instructor-officers with less experience (in groups 1 and 2) have a lower rate of exhaustion (19.0 % and 26.7 %).

Respondents in group 1 often feel satisfied (52.4 %). However, over time, service related obstacles, as well as significant physical and mental stress, can reduce the degree of satisfaction with the profession. In particular, 45.2 % of respondents in group 3 and 46.4 % in group 4 only sometimes feel satisfied with their jobs.

DISCUSSION

Based on the analysis and synthesis of the literature [1-3], we have found that the concept of "professional health" is defined as an integral characteristic of the functional state of the body, the mental state of the individual, which is characterized by the dynamic harmony of internal experiences and the associated efficiency and success of professional activities. The syndrome of professional deformation is a natural phenomenon for those categories of specialists who work with people and whose activities are impossible without business communication [11, 12]. At the same time, it has been determined that the presence of unfavorable factors in professional activities can cause a progressive feeling of dissatisfaction with the profession, internal tension, a sense of psychological discomfort, and self-doubt. With the repetition of unfavorable work or pedagogical situations, such mental states can be consolidated and turn into stable personality traits (for example, proneness to conflict, irritability, suspicion, indifference to others

| Psychological indicators of deformation | Frequency of manifestation | Groups of instructor-officers | | | | |
|---|----------------------------|-------------------------------|----------------|----------------|-------------------|--|
| | | Group 1 n = 21 | Group 2 n = 45 | Group 3 n = 42 | Group 4 n = 28 | |
| Excessive tension | a | 9.5 | 11.1 | 23.8 | 32.1 | |
| | b | 33.3 | 40.0 | 33.3 | 35.7 | |
| | с | 42.9 | 35.6 | 31.0 | 25.0 | |
| | d | 14.3 | 13.3 | 11.9 | 7.2 | |
| | a | 9.5 | 15.6 | 21.4 | 28.5 | |
| State of nervousness | b | 28.6 | 33.3 | 31.0 | 42.9 | |
| | c | 47.6 | 37.8 | 33.3 | 21.4 | |
| | d | 14.3 | 13.3 | 14.3 | 7.2 | |
| | а | 4.8 | 6.7 | 16.7 | 17.9 | |
| Emotionality and empathy | b | 23.8 | 44.4 | 47.6 | 42.8 | |
| | c | 47.6 | 31.1 | 23.8 | 21.4 | |
| | d | 23.8 | 17.8 | 11.9 | 17.9 | |
| | а | 14.4 | 13.3 | 7.1 | 7.2 | |
| Exhaustion | b | 47.6 | 44.4 | 40.5 | 35.7 | |
| | c | 19.0 | 26.7 | 33.3 | 32.1 | |
| | d | 19.0 | 15.6 | 19.1 | 25.0 | |
| Job satisfaction | а | 4.8 | 6.7 | 16.7 | 17.9 | |
| | b | 19.0 | 31.1 | 45.2 | 46.4 | |
| | c | 52.4 | 44.4 | 28.6 | 25.0 | |
| | d | 23.8 | 17.8 | 9.5 | 10.7 | |

Table 2. Correlation of psychological indicators of deformation in instructor-officers as a negative factor of their professional health (n = 136), %

Legend: a – never; b – sometimes; c – often; d – always.

and to work in general) [5, 6, 15]. These mental formations of the personality begin to manifest themselves in professional activities and communication, thereby causing the emergence of unusual ways (models) of behavior. All this leads to a deterioration in the professional health of instructor-officers and a reduction in their professional longevity.

The conducted questionnaire survey allowed us to identify the following key professional and psychological indicators in the activities of instructor-officers of higher educational institutions: excessive tension; state of nervousness; presence of stressful phenomena; manifestations of proactive attitude during the performance of professional tasks; emotionality and empathy; rapport; exhaustion; job satisfaction; desire to change the line of work; desire to resign. Thus, in particular, the level of instructor-officer's stress resistance depends on how often he or she transfers negative emotions to his or her professional (colleagues, cadets) or social (family or friends) environment. In addition, it became possible to establish the sociability (rapport) of the instructor-officers' personality, which can underlie such traits of their behavior as openness, tolerance, proneness to conflict, or aggressiveness. It is also important to determine the respondents' desire to resign and terminate their service activities, as well as to find out the level of their satisfaction with the teaching profession. If the desire to resign or change the line of work occurs frequently, then we can talk about the presence of professional deformation that blocks the development of the individual as a professional. At the same time, an indifferent or, on the contrary, fanatical attitude to one's career causes a sense of anxiety. After all, in such circumstances, the instructor-officer does not strive to acquire the appropriate competence, which slows down his or her professional development and contributes to deformation (performing duties using outdated approaches, ignoring new methods of pedagogical work, etc.).

The results of the questionnaire survey are of some concern, as frequent thoughts about changing the line of work indicate an average level of deformation and become an obstacle to further professionalization of specialists. It would be logical to assume that such instructor-officers do not see any prospects for their service activities and remain at the same level of professional development, working with little enthusiasm or even in a reluctant manner. At the same time, similar deformational changes in personality can, on the contrary, contribute to the instructor-officer's constant tension and anxiety, because his or her views and standpoints are formed based on a progressive desire to change the line of work as soon as possible, to achieve success in another field (implementation of own business projects, consulting practice, etc.). This confirms the conclusions of many scientists [16-18], whose works note that professional deformation causes an exacerbation of personality manifestations that arises as a result of several conditions related to service activities.

CONCLUSIONS

It has been established that in the pedagogical activities of instructor-officers, professional deformation does not develop so rapidly, but its manifestations can be quite pronounced with the experience gained. The instructor-officers have dynamics of levels of professional deformation: from initial to deep. With little experience (up to 5 years), the professional and psychological indicators of instructors' deformation are insignificant, which is caused by the adaptation period of their formation. Instead, instructor-officers become more confident with more experience but some indicators (the presence of stress, proactive attitude to performing professional tasks, exhaustion, etc.) show a progressive tendency to the development of deformational changes. Constant repetition of actions, teaching the same academic subject areas, frequent lack of opportunities for personal development, and periodic conflicts at work contribute to the progression of the desire to leave the higher educational institution with specific learning environment. This requires appropriate corrective psychological measures, without which cases of deviant behavior (e.g., substance abuse as a way to overcome stress or compensate for exhaustion) may become widespread, which is certainly detrimental to professional health and an obstacle to further work.

PROSPECTS FOR FURTHER RESEARCH

It is planned to develop a program of measures to prevent professional deformation in instructor-officers to strengthen their professional health.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Ivan M. Okhrimenko

National Academy of Internal Affairs 1 Solomyanska Square, 03035 Kyiv, Ukraine e-mail: ivango-07@ukr.net

ORCID AND CONTRIBUTIONSHIP

Ivan M. Okhrimenko: 0000-0002-8813-5107 A B Olga G. Marchenko: 0000-0002-8040-9687 A E Olena Yu. Sashurina: 0000-0003-4857-7645 A E Olha M. Pasko: 0000-0001-9555-1101 C D Liudmyla M. Prudka: 0000-0001-5440-2361 C D Tetyana V. Matiienko: 0000-0001-9695-2222 D F Inha A. Serednytska: 0000-0002-8839-2453 E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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REVIEW ARTICLE

CONTENTS 🔼

The use of specialized (medical) knowledge in the criminal process: the practice of the European Court of Human Rights

Andrii Skrypnyk¹, Tarana Aliieva², Ivan Titko¹

¹ POLTAVA LAW INSTITUTE OF YAROSLAV MUDRYI NATIONAL LAW UNIVERSITY, POLTAVA, UKRAINE

² KHARKIV NATIONAL MEDICAL UNIVERSITY, KHARKIV, UKRAINE

ABSTRACT

Aim: This article is aimed at raising awareness and stimulating scientific discussion on the necessity of involving qualified medical professionals in conducting criminal procedural actions that involve intervention in human somatic rights, in order to further improve the legal instruments ensuring compliance with the European Court of Human Rights (hereinafter referred to as the ECHR) standards in this field.

Materials and Methods: In preparing the article, the following issues were worked out: the provisions of international legal acts; legal positions of the ECHR related to the use of medical knowledge in the criminal process; scientific studies of various aspects of the use of medical knowledge in the criminal process. The methodological basis of the research is dialectical, comparative-legal, systemic-structural, analytical, synthetic, complex research methods.

Conclusions: The use of medical knowledge in the criminal process generally takes two forms: (a) expert and (b) ancillary. The expert form, particularly forensic medical examination, must adhere to a set of criteria reflected in the practice of the ECHR. Personal searches involving penetration into human body cavities generally align with the requirements of the he European Convention on Human Rights (hereinafter referred to as the Convention), provided certain conditions are met, including medical considerations. The criterion for the admissibility of coercive collection of biological samples for examination is the existence of samples independent of the individual's will.

KEY WORDS: specialized (medical) knowledge, forensic medical examination, collection of biological samples, investigative actions, ECHR practice, criminal process

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INTRODUCTION

Criminal procedural activities often involve significant intrusion into the sphere of somatic rights of individuals. Essential to these actions are medical knowledge, the carriers of which typically directly participate in conducting relevant procedural actions. Achieving a reasonable balance between the effectiveness of criminal procedural evidence and unwavering respect for human rights and freedoms during its conduct is impossible without delineating guidelines. Searching for such guidelines for states that recognize European values is entirely justified in the practice of the ECHR.

AIM

This article is aimed at raising awareness and stimulating scientific discussion on the necessity of involving qualified medical professionals in conducting criminal procedural actions that involve intervention in human somatic rights, in order to further improve the legal instruments ensuring compliance with the ECHR standards in this field.

MATERIALS AND METHODS

The basis for preparing the article was empirical material – the case law of the ECHR, which: (a) is grounded in conventional requirements and European standards in the field of human rights protection; (b) is taken into account in the national legal system during the application of the overarching principle of criminal proceedings – the rule of law. The selection of specific ECHR judgments was determined by their significance in assessing the lawfulness of certain interventions into the sphere of Convention rights during procedural actions involving experts in the field of medicine. In total, 12 ECHR judgments were analyzed. Auxiliary materials included compilations of ECHR case law by specific Convention articles, as well as scientific articles.

During the investigation, a combination of general scientific and specific methods of cognition was used, including the systemic-structural method, the method of generalization, and methods of analysis and synthesis. The systemic-structural method allowed for the formation of a comprehensive view of the system of procedural actions involving experts with specialized (medical) knowledge. The method of generalization was used during the study of ECHR case law to formulate criteria for the lawfulness of procedural actions in light of conventional standards. The methods of analysis and synthesis facilitated the identification of key motifs in the ECHR's positions, which subsequently enabled the formulation of a comprehensive (synthesized) understanding of conventional standards regarding the use of specialized (medical) knowledge in criminal proceedings.

REVIEW AND DISCUSSION

Criminal procedural activities involve the use of various forms of specialized (including medical) knowledge, which can be grouped into two main blocks: a) expert; b) ancillary (consultative). The first block, associated with conducting forensic examination, entails not only autonomy in the expert's participation process (the expert conducts the investigation independently) but also in the evidential value of the results of the medical expert's participation (the expert's conclusion serves as an independent procedural evidence source subject to evaluation along with others on general principles (for example, Part 2 of Article 84, Part 2 of Article 94 of the Criminal Procedure Code of Ukraine). The second block – ancillary (consultative) – encompasses various procedural actions where specialized (medical) knowledge is involved in one form or another, including: examination of a corpse with the participation of a doctor; exhumation; examination involving a forensic medical expert, doctor, or specialist; personal search involving examination of human body cavities; collection of biological samples for examination; participation of a doctor during forced feeding of suspects or accused persons held in detention facilities. The scope of this work does not allow for a comprehensive review of conventional standards for the protection of rights and freedoms within all of the listed procedural actions. Therefore, this work will focus only on specific ones.

I. The specificity of using expert conclusions on medical issues in the context of implementing conventional guarantees. The need to examine the specifics of using expert conclusions on medical issues in the criminal process through the lens of conventional standards arises from two factors: firstly, the issues addressed by the expert touch upon the implementation not only of the right to a fair trial (Article 6 of the Convention), but also various other conventional guarantees. Secondly, the conventional aspects of using expert conclusions through the prism of Article 6 of the Convention regarding medical issues acquire particular substantive significance. For example, the neutrality of experts becomes especially important when determining the limitation of conventional powers (Article 5 of the Convention), particularly in cases of providing psychiatric assistance to individuals involuntarily: "The Court further notes that all the forensic psychiatric reports leading to the involuntary medical treatment of the applicant were drawn up by specialists from the same hospital, without a second, independent opinion being sought."[1].

The specific features of the opinion of an expert on medical issues include:

1) The presence of medical expert activity in a state monopoly, which, however, should not be affected by the impartiality of experts: "...the Court is unable to accept the applicant's arguments that the objectivity of expert opinions in cases of medical negligence can automatically be called into doubt on account of the fact that the experts are medical practitioners working in the domestic healthcare system. On the contrary, the Court has held that it is normal for expert opinions in such cases to be given by medical practitioners (see Csősz v. Hungary, no. 34418/04, § 35, 29 January 2008). Moreover, the Court has also held that the very fact that an expert is employed in a public medical institution specially designated to provide expert reports on a particular issue and financed by the State does not in itself justify the fear that such experts will be unable to act neutrally and impartially in providing their expert opinions (see Letinčić v. Croatia, no. 7183/11, § 62, 3 May 2016)" [2]. Traditionally, the assessment of the fairness of judicial proceedings is based on the available procedural guarantees: "What is important in this context is that the participation of an expert in the proceedings is accompanied with adequate procedural safeguards securing his or her formal and de facto independence and impartiality" [2];

2) Categorizing forensic medical examinations as one of the tools ensuring positive obligations of the state regarding the realization of the right to life (Article 2 of the Convention): a) obligation to conduct a proper investigation utilizing, among other things, the results of forensic medical examinations: "The authorities must take whatever reasonable steps they can to secure the evidence concerning the incident (a death, caused by the use of force by State agents), including, inter alia, eyewitness testimony, forensic evidence and, where appropriate, an autopsy which provides a complete and accurate record of injury and an objective analysis of the clinical findings, including the cause of death (as regards autopsies, see, for example, Salman v. Turkey [GC], no. 21986/93, § 106, ECHR 2000-VII; on the subject of witnesses, see, for example, Tanrıkulu v. Turkey [GC], no. 23763/94, § 109, ECHR 1999-IV; and, as regards forensic examinations, see, for example, Gül v. Turkey, no. 22676/93, § 89, 14 December 2000)"[3]; b) deeming unacceptable the lack of cooperation between forensic medical institutions, as well as the use of unsubstantiated expert conclusions [4];

3) A special level of requirements for the independence of experts, arising from the significance of the answers they provide to the court: a) Regarding the independence of experts: "A requirement of independence of the effective domestic system set up to determine the cause of death of patients in the care of the medical profession is implicit in this context (see Byrzykowski, cited above, § 104). This above all means not only a lack of hierarchical or institutional connection, but also the formal and de facto independence of all parties tasked with conducting an assessment as part of proceedings set up to determine the cause of death of patients from those implicated in the events (see, mutatis mutandis, Denis Vasilyev v. Russia, no. 32704/04, § 148, 17 December 2009)"[5]; b) Regarding the increased significance of expert opinion: "The medical reports of expert witnesses are very likely to carry crucial weight in a court's assessment of the highly complex issues of medical negligence, which gives them a particularly special role in the proceedings (see Sara Lind Eggertsdóttir v. lceland, no. 31930/04, § 47, 5 July 2007)" [5].

II. The conduct of a personal search, involving the exposure and/or examination of body cavities, in the context of implementing conventional safeguards. In the activities of criminal justice agencies, there may be an objective need to carry out procedural actions involving the examination of exposed parts of the body or the inspection of its natural cavities. Within the framework of the national procedural system, this may involve the identification parade (Article 241 of the CPC of Ukraine) or body search (Part 3 of Article 208, Part 5 of Article 236 of the CPC of Ukraine). In the context of conducting these procedural actions, adherence to conventional safeguards becomes particularly important: prohibition of torture (Article 3 of the Convention), right to a fair trial (Article 6 of the Convention), right to respect for private and family life (Article 8 of the Convention).

Conducting a personal search involving the exposure of the individual. The established practice of the ECHR is characterized by an approach according to which procedural actions involving the exposure of an individual are not only subject to scrutiny under Article 3 of the Convention, but may also, provided that guarantees are upheld, be reconciled with its requirements: "The Court notes that it has already had occasion to apply the principles of Article 3 of the Convention set out above in the context of strip and intimate body searches. A search carried out in an appropriate manner with due respect for human dignity and for a legitimate purpose (see mutatis mutandis, Yankov v. Bulgaria, no. 39084/97, §§166-67, ECHR 2003-XII where there was no valid reason established for the shaving of the applicant prisoner's head) may be compatible with Article 3" [6]. The justification for such searches may be warranted "on occasion to ensure prison security or to prevent disorder or crime (see Valašinas v. Lithuania, no. 44558/98, § 117, 24 July 2001; Iwańczuk v. Poland, no. 25196/94, § 59, 15 November 2001; Van der Ven v. the Netherlands, no. 50901/99, § 60, ECHR 2003II; Frérot v. France, no. 70204/01, § 38, 12 June 2007; and Dejnek v. Poland, no. 9635/13, § 60, 1 June 2017)" [7], and their lawful implementation should be accompanied by due legal procedure, respect for human dignity and a legitimate purpose ("They should be carried out in an appropriate manner with due respect for human dignity and for a legitimate purpose (see Wainwright, cited above, § 42; and Dejnek, cited above, § 60)"). In the event that the method of conducting a search of a person leads to the deterioration of the already extremely vulnerable situation of the searched person, then it is fully justified, according to the practice of the ECHR, to establish a violation of Article 3 of the Convention, which took place, in particular:

- where a prisoner was obliged to strip in the presence of a female officer, his sexual organs and food touched with bare hands (Valašinas v. Lithuania, no. 44558/98, § 117, ECHR 2001-VIII);
- where a search was conducted before four guards who derided and verbally abused the prisoner (Iwańczuk v. Poland, no. 25196/94, § 59, 15 November 2001);
- where the search has no established connection with the preservation of prison security and prevention of crime or disorder (Iwańczuk, v. Poland, no. 25196/94, §§ 58-59; Van der Ven v. the Netherlands, no. 50901/99, §§ 61-62, ECHR 2003-II) [6].

In turn, a violation of the established rules for conducting a search of a person, carried out in order to achieve a legitimate goal, although it will not constitute a violation of Article 3 of the Convention, but will indicate incompatibility with another convention guarantee (paragraph 2 of Article 8 of the Convention): "In a case concerning the strip search of visitors to a prisoner which had a legitimate aim but had been carried out in breach of the relevant regulations, the Court found that this treatment did not reach the minimum level of severity prohibited by Article 3 but was in breach of the requirements under Article 8 § 2 of the Convention (see Wainwright v. the United Kingdom, no. 12350/04, 20 September 2006)" [6]. The given example once again demonstrates the contiguity of a number of conventional guarantees that may be violated during procedural actions involving the exposure of a person.

Carrying out a personal search related to the examination of body cavities. The complex of measures aimed at obtaining evidence hidden in the cavities of the human body holds particular importance for upholding human rights and freedoms, as well as for achieving the goals of criminal procedural activity. For example, within the scope of examining one of the criminal cases, through the testimony of witnesses, it was established that the accused immediately after the robbery swallowed the victim's expensive necklace. This fact was subsequently confirmed by the results of a medical examination using X-rays [8]. Considering the unique evidentiary value of items that may be hidden in various cavities of the human body, the significant intrusion into an individual's personal space, as well as the substantial impact on the individual's health of the procedure for detecting and retrieving hidden items, it is entirely justified to address the question of striking a balance between achieving the objectives of evidentiary activity and adhering to conventional standards during interventions in the sensitive sphere of human existence. To clarify the factors that should be considered for this purpose, it is necessary to refer to the criteria developed by the practice of the ECHR.

Firstly, it is noteworthy that the lawfulness of conducting procedural actions aimed at detecting and retrieving evidence (for example, a packet containing narcotics) from the body cavities of a person may be assessed by the ECHR in terms of compliance with three conventional standards simultaneously: a) Article 3 of the Convention (prohibition of torture) - the acceptability of the method of detection and retrieval, and the prevention of excessive physical suffering in the process; b) Article 8 of the Convention (right to respect for private and family life) – the proportionality of the intrusion into privacy; c) Article 6 of the Convention (right to a fair trial) - the fairness of using the obtained evidence against the individual, particularly in the context of implementing the defendant's right to remain silent. It is indicative that the described method of obtaining evidence is not a priori considered unacceptable: "Even where it is not motivated by reasons of medical necessity, Articles 3 and 8 of the Convention do not as such prohibit recourse to a medical procedure in defiance of the will of a suspect in order to obtain from him evidence of his involvement in the commission of a criminal offence." [9].

Secondly, the evidentiary value of procedural sources obtained in this manner necessitates "a strict scrutiny of all the surrounding circumstances": "However, any recourse to a forcible medical intervention in order to obtain evidence of a crime must be convincingly justified on the facts of a particular case. This is especially true where the procedure is intended to retrieve from inside the individual's body real evidence of the very crime of which he is suspected" [9]. Therefore, the decision to carry out the relevant medical intervention must be absolutely balanced and objectively determined by a combination of specific circumstances of the case, including: a) the severity of the committed offense; b) the possibility of obtaining evidence through alternative means (for example, instead of using an emetic substance – waiting for the object to be naturally expelled (see 9, § 19, 77); instead of catheterization for obtaining urine samples – taking a blood sample (see 10, § 72); c) the absence of any risk of lasting harm to the person's health (see Nevmerzhitsky v. Ukraine, no. 54825/00, § 94 and 97, ECHR 2005-II, and Schmidt v. Germany (dec.), no. 32352/02, 5 January 2006) [9].

Thirdly, the guarantees for adherence to conventional standards during the acquisition of evidence resulting from the examination of body cavities include the following:

a) Minimization of physical suffering during medical procedures: "... the manner in which a person is subjected to a forcible medical procedure in order to retrieve evidence from his body must not exceed the minimum level of severity prescribed by the Court's case-law on Article 3 of the Convention. In particular, account has to be taken of whether the person concerned experienced serious physical pain or suffering as a result of the forcible medical intervention (see Peters v. the Netherlands, no. 21132/93, Commission decision of 6 April 1994, DR 77-B; Schmidt v. Germany (dec.), no. 32352/02, 5 January 2006; and Nevmerzhitsky v. Ukraine, no. 54825/00, §§ 94 and 97, ECHR 2005-II)" [9]. In the opposite case, individuals may experience "feelings of insecurity, anguish, and stress that were capable of humiliating and debasing him," which would lead to the determination of a violation of Article 3 of the Convention [10];

b) Quality medical supervision during the procedural action: "Another material consideration in such cases is whether the forcible medical procedure was ordered and administered by medical doctors and whether the person concerned was placed under constant medical supervision (see, for example, Ilijkov v. Bulgaria, no. 33977/96, Commission decision of 20 October 1997, unreported)" [9];

c) Prevention of negative and lasting impact of intervention on the person's health: "A further relevant factor is whether the forcible medical intervention resulted in any aggravation of his or her state of health and had lasting consequences for his or her health (see Ilijkov v. Bulgaria, no. 33977/96, Commission decision of 20 October 1997, unreported, and, mutatis mutandis, Krastanov v. Bulgaria, no. 50222/99, § 53, 30 September 2004)" [9].

III. Collection of biological samples for forensic examination in the context of implementing conventional safeguards. Biological samples collected for forensic examination can play a crucial evidentiary role (for example, in establishing the ownership of DNA materials left at the scene of a crime by a suspect or accused). However, their collection involves a significant intrusion into privacy, similar to the search of a person mentioned earlier. Therefore, the relevance of the entire block of conventional standards outlined above (prohibition of torture (Article 3 of the Convention), right to a fair trial (Article 6 of the Convention), right to respect for private and family life (Article 8 of the Convention) remains pertinent. However, certain issues related to the protection of rights and freedoms gain particular substantive significance, and it is these issues that will be the focus of further investigation.

One of the most debated issues both in academic discourse and within the practice of the ECHR remains the problem of upholding the right to silence when biological samples are forcibly collected. The essence of the right to silence in the context of the right to a fair trial is formulated as follows: "The right not to incriminate oneself, in particular, presupposes that the prosecution in a criminal case seek to prove their case against the accused without resort to evidence obtained through methods of coercion or oppression in defiance of the will of the accused (see, inter alia, Saunders v. the United Kingdom, 17 December 1996, Reports 1996-VI, § 68; Heaney and McGuinness v. Ireland, no. 34720/97, §§ 40, ECHR 2000-XII; J.B. v. Switzerland, no. 31827/96, § 64, ECHR 2001-III; and Allan v. the United Kingdom, no. 48539/99, § 44, ECHR 2002-IX)" [9]. On the one hand, the lack of consent from the suspect or accused for the collection of evidence by the prosecution, which may later form the basis of the accusation (effectively evidence against the individual), is quite obvious. On the other hand, extending the verbal construct (the right to silence) to categories of a different nature (such as biological material) is impossible without adjustments that organically arise from the legal difference between statements or explanations and objectively existing physiological results of human life activities (such as blood, urine, saliva). Let's try to understand further the guidelines proposed by the existing ECHR practice.

Firstly, at the level of the initial thesis, it can be noted that the ECHR acknowledges a direct connection between the collection of biological samples and the violation of an individual's privacy, which, however, under certain conditions, is deemed permissible: "Thus, while compulsory testing of alcohol levels may be regarded as amounting to a violation of the applicants' private life within the meaning of Article 8 § 1 of the Convention, it may also be seen as necessary for the prevention of criminal offences and the protection of the rights and freedoms of others" [11].

Secondly, different types of evidence originating from an individual require differentiated assessment regarding the observance of the right to silence in the event of their forced collection. Within this particular aspect, the ECHR has repeatedly emphasized the permissibility of compulsory collection of biological samples, such as blood, urine, skin tissues, for DNA analysis: "As commonly understood in the legal systems of the Contracting Parties to the Convention and elsewhere, it does not extend to the use in criminal proceedings of material which may be obtained from the accused through the use of compulsory powers but which has an existence independent of the will of the suspect such as, inter alia, documents acquired pursuant to a warrant, breath, blood and urine samples and bodily tissue for the purpose of DNA testing" [12]. The key parameter that allows for the use of compulsory means to obtain such samples is their existence independently of the will of the accused. This can be understood as the absence of compulsion on the individual to perform any deliberate actions to produce samples (non-verbal analogs of words that cannot be compelled in criminal proceedings): "To obtain such material, a defendant is requested to endure passively a minor interference with his physical integrity (for example when blood or hair samples or bodily tissue are taken). Even if the defendant's active participation is required, it can be seen from Saunders that this concerns material produced by the normal functioning of the body (such as, for example, breath, urine or voice samples)" [9]. In such a case, there is no suppression of the individual's will (samples are formed by the body independently), and there is no significant interference with the individual's health.

Thirdly, the practical significance lies in the approach proposed by the applicants within one of the ECtHR decisions regarding the classification of categories covered by the right to silence: "... if a clear distinction could be drawn in every case between the use of compulsion to obtain incriminatory statements on the one hand and "real" evidence of an incriminatory nature on the other)" [13]. Thus, according to the described logic, obtaining "verbal" evidence despite the individual's unwillingness to provide it would indicate a violation of the right to silence, whereas obtaining "real" evidence (those that exist independently of the individual's will) would not.

The issue of using specialized (medical) knowledge in criminal proceedings has been extensively explored in various aspects within scientific research. General procedural principles regarding the utilization of specialized (medical) knowledge during criminal investigations have been analyzed by Yu. Chornous, A. Lisitskyi [14], Yu. Myroshnychenko [15]. Certain aspects of compulsory collection of biological samples for examination in the context of the ECHR practice have been reflected in the work involving one of the authors of this article, I. Titko, in collaboration with O. Kaplina and O. Shylo [16]. An overview of conducting forensic medical examinations, personal searches, or the collection of biological samples for examination from one perspective or another is reflected in the manuals on ECHR practice regarding the application of Article 3 of the Convention [17], Article 5 of the Convention [18], Article 6 of the Convention [19], and Article 8 of the Convention [20]. The national interpretation of the proper legal procedure in the application of specialized (medical) knowledge in criminal proceedings is presented in the works of D. Abbasova [21], A. Nechval [22], M. Hryha [23], L. Basiuk [24]. However, scientific works demonstrate a deficit in comprehensive understanding of the implemented ECHR conventional standards regarding the use of specialized (medical) knowledge in criminal proceedings, which, due to the lack of proper regulation at the national level, require further improvement and implementation into legal practice. This article provides an overview of key standards (requirements) set forth by the ECHR practice for procedural actions directly related to the use of specialized (medical) knowledge in criminal proceedings, including forensic medical examinations, personal searches, or compulsory collection of samples for examination. However, the list of procedural actions provided is not exhaustive, indicating the need for further research.

CONCLUSIONS

 The main forms of using specialized (medical) knowledge in criminal proceedings include:

 a) expert (related to conducting expert examinations);
 b) auxiliary (consultative) (encompassing a variety of procedural actions involving a medical specialist (personal search, examination, collection of biological samples for examination,

 forced feeding, etc.)). Standards for the proper conduct of procedural actions using specialized (medical) knowledge are developed by the ECHR within the framework of applying a number of conventional guarantees: the right to life (Article 2 of the Convention), prohibition of torture (Article 3 of the Convention), the right to liberty and security (Article 5 of the Convention), the right to a fair trial (Article 6 of the Convention), the right to respect for private and family life (Article 8 of the Convention).

- Among the requirements for conducting forensic medical examinations in the practice of the ECHR, the following can be identified: 1) Medical-expert activities are to be under state monopoly, but this should not compromise the impartiality of the experts; 2) Forensic medical examination is considered one of the instruments ensuring positive obligations of the state regarding the right to life (the necessity of appointing examinations and organizing adequate cooperation between forensic medical and law enforcement agencies);
 There is a special emphasis on the independence of forensic medical experts, given the significant weight of the answers they provide to the court.
- 3. According to the ECHR practice, personal searches involving the exposure of the person are permitted only in exceptional cases (such as ensuring the security of detention facilities, preventing mass disturbances, and criminal offenses), and their lawful conduct must be accompanied by due legal procedure, respect for human dignity, and a legitimate purpose. The justification of a personal search involving the examination of body cavities is assessed by the ECHR taking into account the specific circumstances of the case (severity of the offense, possibility of obtaining evidence by alternative means, absence of danger to the person's health), as well as based on the presence of guarantees, including: a) Minimization of physical suffering; b) Quality medical supervision; c) Prevention of prolonged negative impact on the person's health.
- 4. Within the framework of conventional standards, the collection of biological samples for forensic examination holds a pivotal place in terms of respecting an individual's right to silence (in the context of the right to a fair trial – Article 6 of the Convention). The key criterion for the admissibility of compulsory sample collection for examination is the existence of samples independent of the individual's will (exhaled air, blood, urine, skin), the collection of which does not involve significant intrusion into the person's health.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR Ivan Titko

Poltava Law Institute of Yaroslav Mudryi National Law University, 5 Vitaliia Hrytsaienka prospect, 36000 Poltava, Ukraine e-mail: titko.iv@gmail.com

ORCID AND CONTRIBUTIONSHIP

Andrii Skrypnyk: 0000-0003-4979-2152 A B D Tarana Aliieva: 0000-0002-3002-667X B D E Ivan Titko: 0000-0003-4126-6967 A B F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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CONTENTS 🔼

Innovative therapeutic strategies in the treatment of gastroesophageal reflux disease (GERD): A review of progress and perspectives

Piotr Kucharczyk¹, Karolina Anna Parzęcka¹, Michał Jakub Symulewicz², Weronika Zań³, Kinga Szczepanik², Olaf Domaradzki¹, Bartłomiej Kusy¹, Mateusz Michalak¹, Marta Stolińska²

¹MEDICAL UNIVERSITY OF WARSAW, WARSAW, POLAND

²HOSPITAL OF OUR LADY OF PERPETUAL HELP IN WOŁOMIN, WOŁOMIN, POLAND, POLAND ³INDEPENDENT PUBLIC HEALTHCARE CENTER OF THE MINISTRY OF THE INTERIOR AND ADMINISTRATION, GDANSK, POLAND

ABSTRACT

Gastroesophageal Reflux Disease (GERD) is a commonly occurring condition that can significantly impact quality of life. Often considered a lifestyle disease. Traditional treatment methods focus on pharmacotherapy, lifestyle modifications, and in extreme cases, surgical interventions. This article discusses current and novel approaches to managing gastroesophageal reflux disease. The foundation of this work was medical articles and research gathered from the PubMed database. Keywords such as "esophageal reflux treatment", "new technologies in GERD treatment", "innovative reflux treatment methods", were used to facilitate the literature search. In managing gastroesophageal reflux disease, the application of appropriate pharmacological therapy and lifestyle changes for the patient remains key. However, new technologies and treatment methods, such as advanced endoscopic repair procedures, innovative medications, and personalized approaches, are gaining importance. These new strategies can significantly improve patients' quality of life, reduce symptoms, and minimize the need for surgical interventions.

KEY WORDS: GERD, diagnostics, treatment, new technologies

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INTRODUCTION

Gastroesophageal reflux disease, or GERD for short, is a disease of civilization dimensions and affects people of all ages. Although its main symptom is the backflow of food content from the stomach into the esophagus, the above health problem manifests itself not only with the popular heartburn – that is, burning chest pain behind the sternum radiating to the neck or throat, but also manifests itself with extraesophageal ailments. These include asthma, laryngitis, dry cough, esophagitis and esophageal stricture, Barrett's esophagus [1]. In addition to the aforementioned, cardiac, neurological and dental disorders occurring without specific reasons may find their cause in asymptomatic reflux. Incorrectly diagnosed patients usually neglect morning hoarseness, idiopathic sore throat and empty belching [2].

AIM

This paper aims to review and present the current state of knowledge on new therapies used to treat reflux esophageal disease.

MATERIALS AND METHODS

The foundation of this work was medical articles and research gathered from the PubMed database. Keywords such as "esophageal reflux treatment", "new technologies in GERD treatment", "innovative reflux treatment methods", were used to facilitate the literature search. In managing gastroesophageal reflux disease, the application of appropriate pharmacological therapy and lifestyle changes for the patient remains key.

REVIEW AND DISCUSSION

PATHOPHYSIOLOGY OF GERD

Gastroesophageal reflux (GER) does not always represent a pathology of the digestive system. It occurs naturally when the esophagus, with the help of peristaltic movements, effectively eliminates retreating acid. A key element in preventing pathological reflux is the lower esophageal sphincter (LES), which acts as a protective barrier against retreating acidic gastric contents. In order for the LES to work effectively, the gastroesophageal junction must be located in the abdominal cavity, allowing the diaphragm to further enhance its action. An anomaly in the position of the lower esophageal sphincter is a sliding or periaesophageal hernia.

Factors contributing to the development of GERD are primarily abnormalities in the function of the LES. They are caused by the presence of an esophageal hiatus hernia, inefficient esophageal clearance, the presence of an acid pocket and delayed gastric emptying. The use of gravity, which in the standing position helps to remove acid faster, peristalsis, which mechanically removes food contents, and the buffering effect of saliva, whose slightly alkaline pH, close to 6.0, assists in neutralizing acid in the final stage of esophageal cleansing account for a properly functioning esophageal barrier [3].

MAJOR RISK FACTORS FOR ESOPHAGEAL REFLUX

LES DYSFUNCTION

The lower esophageal sphincter (LES) forms a protection that prevents gastric contents from backing up into the esophagus. In gastroesophageal reflux disease (GERD), there is excessive breaking of this barrier and consequent movement of gastric contents into the esophagus. The disease results from weakness of the sphincter, abnormalities in its anatomical structure or impaired esophageal motility [4].

Excessive transient relaxation of the LES along with defective background pressure have been classified as its two main causes of dysfunction. The prevalence of transient increases in abdominal pressures, present, for example, during pushing or blowing the nose, defective neural control, and impaired sphincter muscle have a significant impact on this [5].

Studies indicate that weakness of the LES, occurs in 80% of affected individuals and significantly contributes to the severity of GERD, as manifested by excessive contact between the esophageal mucosa and acid. On endoscopic examination, the condition is visualized as its damage caused by the irritant.

ESOPHAGEAL HERNIA

Esophageal hiatal hernia is the insertion of part of the stomach above the diaphragm through the esophageal hiatus. This situation reshapes the LES, weakening its ability to maintain tightness. Such esophageal threading can lead to inefficiencies in the cooperation of the diaphragm and the LES, which together protect the esophagus from the excessive dumping of gastric contents [6].

ACID POCKET

This is a phenomenon in which hydrochloric acid, proteolytic enzymes, lipases and pepsin accumulate in the lower part of the esophagus. The condition is often seen in patients with gastroesophageal reflux disease (GERD) and those suffering from a hiatal hernia. The presence of an acid pocket is thought to contribute to lower esophageal sphincter (LES) dysfunction and irritation of the mucosal epithelium. Chronic exposure of the esophageal walls to accumulated acidic substances can lead to inflammation, epithelial damage, and more serious consequences such as esophageal stenosis, ulceration, and even precancerous conditions such as Barrett's esophagus [7].

CURRENT TREATMENTS FOR GASTROESOPHAGEAL REFLUX DISEASE

A variety of approaches are used to treat different types of gastroesophageal reflux disease (GERD), tailored to the severity of symptoms and patient response to treatment[8]. Primary approaches include:

GENERAL RECOMMENDATIONS

Lifestyle modifications: Weight reduction in overweight patients, elevation of the bed headboard during sleep, and avoiding eating at least 3 hours before bedtime are recommended [9].

PHARMACOLOGICAL TREATMENT

Proton pump inhibitors (PPIs): Considered most effective in the treatment of GERD, especially in healing mucosal damage and esophagitis [10].

H2 blockers: May be used, but their role is limited.

Topical preparations: Such as Esoxx[®] (available in Poland), alkaloids and alginates [11] are used to treat episodes and recurrences of reflux for better symptom control.

Prokinetics: These are not recommended because of their lack of efficacy in GERD. In the overlap syndrome of GERD and dyspepsia, the addition of a prokinetic to improve gastric contractility (e.g., itopride) may be considered [12].

SURGICAL TREATMENT – LAPAROSCOPIC FUNDOPLICATION

Laparoscopic fundoplication, a procedure known as Nissen surgery, is recommended as a therapeutic option for selected cases of refractory gastroesophageal reflux disease (GERD) where conventional treatments are unsuccessful. Qualification for this surgical intervention requires meeting certain clinical criteria, which include persistent reflux symptoms despite pharmacotherapy, the presence of Barrett's esophagus, vitamin B12 deficiency and multiple erosions and chronic gastrointestinal bleeding. The fundoplication procedure involves laparoscopically wrapping the upper part of the stomach around the lower esophagus, which increases pressure on the lower esophageal sphincter and significantly reduces the frequency of reflux episodes. Evaluating the effectiveness of this method requires preoperative testing, including esophageal manometry and pH-metry, to confirm the diagnosis of GERD and assess the functionality of the lower esophageal sphincter.

EPISODIC REFLUX TREATMENT

For episodic reflux that occurs less than twice a week and does not reduce the patient's quality of life, outpatient treatment is recommended. A number of preparations can be used to relieve reflux symptoms. Esoxx® One, which contains hyaluronic acid and chondroitin sulfate, forms a protective barrier on the esophageal mucosa, which contributes to the relief of symptoms associated with reflux esophagitis. It is recommended to be taken once a day, optimally before the main meal, to maximize protection of the esophageal wall from the aggressive effects of gastric acid.

Histamine H2 receptor antagonists, such as ranitidine or famotidine, effectively reduce gastric acid synthesis by inhibiting the action of histamine. They are recommended to be taken twice daily, before breakfast or dinner, for optimal control of reflux symptomatology and prevention of complications.

Innovative therapies emerging in the treatment of gastroesophageal reflux disease

Current research into improving the treatment of gastroesophageal reflux disease focuses on, among other things: the use of P-CABs – potassium-dependent proton pump blockers, the development of endoscopic techniques, lower esophageal sphincter electrostimulation, TRPV1 receptor inhibition, inhibition of nuclear factor NF-kB activation, and the use of bile acid-binding agents in a new formulation.

POTASSIUM-COMPETITIVE ACID BLOCKERS (P-CABS)

Effective proton pump inhibition is the cornerstone of GERD therapy. Widely used PPIs reduce the need for surgery, but are not always fully effective. 40-55% of patients taking the drug show partial resistance or intolerance to them. Potassium-competent acid blockers (P-CABs) offer an alternative, bringing rapid and long-lasting control of acid secretion and can protect the esophageal mucosa. As a primary or adjunct treatment, P-CABs can provide significant benefits for patients who do not respond to PPIs, especially in relieving reflux symptoms. The main differences between PPIs and P-CABs stem from their mechanism of action and their effectiveness. PPIs show effect only after repeated use, as they require activation and bind irreversibly to the proton pump showing effect after repeated administration and when taken on an empty stomach. P-CABs act directly and reversibly, providing rapid and sustained efficacy regardless of the time of intake, making them more effective in some aspects, especially in controlling nocturnal acid secretion [13]. Tegoprazan is a P-CAB drug that has been successful in GERD therapies conducted in Japan [14]. This drug is not yet in widespread use, due to concerns about the following ailments: hypergastrinemia and hypochlorhydria. The first refers to elevated gastrin levels in the blood. The second refers to a complete lack of hydrochloric acid in the stomach. Nonetheless, studies are continually being conducted in many Asian countries in patients with erosive reflux disease. In addition, given the high efficacy of vonoprazan in triple therapy against Helicobacter pylori and the disease burden associated with this infection, such as gastric cancer, the indications for this drug are expected to be further expanded [15].

ELECTRICAL STIMULATION IN GASTROESOPHAGEAL REFLUX DISEASE

Electrical stimulation of the lower esophageal sphincter (LES) is a novel method of treating GERD, especially for patients insufficiently responsive to medication. The method involves implanting electrodes that, by emitting low electrical pulses, enhance LES function and prevent reflux. In a two-year randomized trial of patients who did not respond adequately to treatment with proton pump inhibitors (PPIs), promising results were observed. At the end of the study, the median score on the GERD-related quality of life scale (GERD-HRQL) decreased from an initial 23.5 points to 0 points, indicating complete elimination of symptoms in most participants (p < 0.001). In addition, the median time that esophageal pH levels remained below 4 decreased from 10% to 4%, indicating a significant improvement in control of gastric acidity (p < 0.001). More importantly, 76% of patients (16 out of 21) were able to stop taking PPIs altogether. No serious side effects associated with the therapy were reported [16, 17]. This approach shows

promise in improving GERD symptoms and patients' quality of life, offering an alternative to traditional treatments such as pharmacotherapy or surgery.

WIRELESSLY POWERED DEVICES IMPLANTED ENDOSCOPICALLY INTO THE SUBMUCOSA OF THE LOWER ESOPHAGEAL SPHINCTER

Following the positive results of studies on electrical stimulation of the lower esophageal sphincter, it was decided to develop a new type of therapy for GERD. It focuses on an implantable, miniature, battery-free device that is implanted into the submucosa of the esophagus, providing its electrical stimulation when appropriate. The goal is to reduce the size and weight of the device while providing effective therapy. The device is powered wirelessly, which minimizes risk and increases safety. In studies conducted on animal models using electrical stimulation of the lower esophageal sphincter (LES) at a frequency of 20Hz and a pulse width of 3ms, effective prevention of gastroesophageal reflux was observed. Subsequently, a human study was conducted, which showed that both a high frequency of 20Hz, with a pulse width of 200µs, and a low frequency in the form of 6 cycles per minute, with a pulse width of 375ms lead to an increase in LES pressure without affecting its ability to relax during swallowing. High-frequency stimulation has also been found to be more energy efficient, meaning the device can run longer without needing to be recharged, offering long and uninterrupted therapy. [18]

IW-3718

IW-3718 is a formulation with a novel therapeutic approach belonging to the group of bile acid sequestrants, such as colesewelam. Its primary action is to bind bile acids in the stomach, helping to reduce their irritating effect on the esophageal mucosa. The drug has been on the market for many years, but the current innovation concerns a new method of releasing the active substance. Its gastric retention technology, known as Acuform, which is also used in other drugs such as gabapentin, allows the drug to be retained in the stomach for an extended period of release and action. This is particularly beneficial for bile acid sequestrants like IW-3718, allowing continuous binding of bile acids for hours, reducing their potentially harmful effects on the esophagus and other parts of the gastrointestinal tract. The results of the IW-3718 study showed a significant improvement in the quality of life of patients with GERD, as measured by the GERD-HRQL scale, with a median reduction in symptoms of 50% from baseline, which was significantly better compared to the placebo group. In addition, more than 60% of patients treated with IW-3718 experienced at least a 50% reduction in heartburn frequency and severity, compared to about 30% in the placebo group. Particularly impressive were the results regarding the reduction of nocturnal reflux episodes, with about 70% of patients reporting less than one episode per week, a significant improvement over placebo. The highest doses of the drug tested significantly reduced GERD symptoms in study patients. The therapy was not associated with significant side effects, except for occasional cases of constipation, justifying its use as an additional option to PPI therapy. [19]

INHIBITION OF NUCLEAR FACTOR NF-кВ ACTIVATION

According to recent studies, inhibiting NF-kB activation may block GERD damage to the esophageal mucosal barrier. Gastroesophageal reflux disease is complex and may be associated with NF-KB activation, which contributes to inflammation and epithelial barrier damage. Inhibiting nuclear factor kappa b (NF-kB) activation in the treatment of gastroesophageal reflux disease (GERD) is a promising approach that may reduce inflammation and protect the esophageal mucosal barrier from further damage. Preclinical studies have shown that NF-KB inhibitors can effectively reduce the expression of pro-inflammatory cytokines such as interleukin (IL)-1B, IL-6 and IL-8, which are released in response to gastroesophageal reflux. These inflammatory factors are known to contribute to damage to the esophageal epithelial barrier and exacerbate GERD symptoms. For example, in one study conducted on animal models with gastroesophageal reflux disease, the use of specific NF-kB inhibitors significantly reduced esophageal mucosal barrier damage and reduced inflammation. In this study, after the application of NF-KB inhibitors, a significant increase in transepithelial electrical resistance was observed, implying an improvement in epithelial barrier integrity. In addition, the use of NF-kB inhibitors resulted in a decrease in intercellular spaces and an increase in desmosome density, further confirming their potential in restoring damaged barrier function. However, further research is still needed to fully understand the role of NF-kB in GERD and to develop safe treatments based on this knowledge [20].

TRPV1 RECEPTOR REGULATION

Studies have shown that Esophageal Epithelial Cells (EECs), responsible for directly confronting refluxed acid, show increased expression of TRPV1 (Transient Receptor Potential Vanilloid 1), a receptor sensitive to pain and heat. Increased expression of this receptor exacerbates esoph-

ageal discomfort, which is crucial in the development of esophagitis. An interesting finding is that menthol, the main active ingredient in peppermint, shows the ability to alleviate this discomfort by interacting with TRPV1. In studies conducted on a mouse model of gastric reflux, it was observed that acid stimulation leads to increased expression of TRPV1 in the EEC, as well as increased activity of this channel. Application of menthol significantly reduces acid-induced calcium ion influx, leading to decreased TRPV1 expression and inhibition of hyperplasia in these cells. These effects suggest the potential use of menthol in the treatment of gastric reflux by modulating the activity of TRPV1 in the EEC, which may represent a new strategy for alleviating gastroesophageal reflux symptoms [21].

CONCLUSIONS

Much remains to be done and researched in the treatment of GERD despite significant progress over the past few years. Proton pump inhibitors so invaluable in the treatment of reflux and GERD are not without their drawbacks. Already used on a large scale in Japan, P-CABs are beginning to have their first positive effects as replacements for PPIs. Advances in the technology of miniaturized electrostimulating devices are significant and may offer a revolution comparable to the development of cardiac pacemakers. Bile acid sequestrants such as IW-3718, and drugs that regulate the corresponding mucosal receptors may prove to be a new mainstay of GERD treatment in the near future.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Piotr Kucharczyk Medical University of Warsaw Warsaw, Poland

e-mail: piotr.kucharczyk97@gmail.com

ORCID AND CONTRIBUTIONSHIP

Piotr Kucharczyk: 0009-0005-7382-9690 A B D E F Karolina Anna Parzęcka: 0009-0007-2284-1221 A B Michał Jakub Symulewicz: 0009-0004-2177-6040 B E Weronika Zań: 0009-0005-8860-8292 A E F Kinga Szczepanik: 0009-0007-5395-7366 B E Olaf Domaradzki: 0009-0000-0533-9386 A B Bartłomiej Kusy: 0009-0000-8355-2262 D E F Mateusz Michalak: 0009-0002-5495-4670 A B Marta Stolińska: 0009-0005-1951-564X D E F

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REVIEW ARTICLE

Long-chain polyunsaturated fatty acids and brain functions – literature review

Bartłomiej Kusy¹, Karolina Parzecka¹, Piotr Kucharczyk¹, Kinga Szczepanik² ¹MEDICAL UNIVERSITY OF WARSAW, WARSAW, POLAND ²HOSPITAL OF OUR LADY OF PERPETUAL HELP IN WOLOMIN, WOLOMIN, POLAND

ABSTRACT

Long-chain ω -3 PUFAs such as DHA and EPA are often present in high amounts in algae and fish. DHA in particular is crucial for the proper development and functioning of the brain because it is the main structural component of ω -3 PUFA in the brain. This makes it an indispensable element of the phospholipids of the nervous membrane. The purpose of this article is to present the benefits of Omega-3 acids in the functioning of the nervous system. The text discusses a literature review focusing on the impact of omega-3 fatty acids. Polyunsaturated fatty acids (PUFAs) are essential for overall health and have been extensively studied for their contributions to human well-being and disease management. Recent research indicates their effectiveness in preventing and treating various diseases. Omega-3 PUFAs have been identified as therapeutic agents, particularly in combating inflammatory conditions like cardiovascular and neurodegenerative diseases. The aim of this article is to present the benefits of omega-3 fatty acids supplementation. Publications outlining properties of polyunsaturated fatty acids on the brain and articles presenting the effects of polyunsaturated fatty acids were reviewed using the Pubmed platform. The review included the keywords "Omega-3 fatty acids." "DHA"

KEY WORDS: Alzheimer's disease, EPA, DHA, Brain, Omega-3, ω-3 PUFAs

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INTRODUCTION

Omega-3 fatty acids are fatty acids that in their chemical structure have a double bond between the third and fourth carbon atoms from the methyl end. The most important compounds belonging to this group include, first of all, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), given their influence on the proper functioning of the brain [1].

It is estimated that about 60% of the brain is made up of fats, with DHA accounting for 40% of the total, while EPA accounts for less than 1%. It is assumed that these are essential compounds for the proper functioning of the nervous system. DHA has many functions in the central and peripheral nervous system, functional in the transmission of signals between neurons, as well as structural, ensuring the maintenance of cell membrane integrity by being one of the main components of phospholipids [2]. Studies confirm their antioxidant, anti-inflammatory and endothelial protective properties.

Man is unable to synthesize them, only a small amount (0.5%) can be formed from alpha-linolenic acid (ALA), which also belongs to the group of polyunsaturated fatty acids [3]. The main sources of EPA and DHA acids are oily marine fish such as salmon, sprat, mackerel,

among others. While vegetable oils do not contain DHA and EPA, they can be a source of ALA, which is found in many plant products such as flaxseed, chia seeds or walnuts. Transport of omega-3 fatty acids is possible via albumin in free or esterified form.

AIM

Long-chain ω -3 PUFAs such as DHA and EPA are often present in high amounts in algae and fish. DHA in particular is crucial for the proper progress and functioning of the cerebrum because it is the main structural component of ω -3 PUFA in the brain. This makes it an indispensable element of the phospholipids of the nervous membrane. The purpose of this article is to present the assistance of Omega-3 acids in the functioning of the nervous system.

MATERIALS AND METHODS

Analytical methods were used for the research. The source data comes from scientific sources from around the world regarding the effects of omega-3 acids on the human nervous system. The articles presenting the

effects of polyunsaturated fatty acids were reviewed using the Pubmed platform. The review included the keywords "Omega-3 fatty acids" "DHA" "EPA" "PUFA.

REVIEW AND DISCUSSION

OMEGA 3 AND FETAL AND CHILD BRAIN DEVELOPMENT

Arachidonic acid (AA) and docosahexaenoic acid (DHA) are crucial for normal brain growth and cognitive development. They rapidly accumulate in the brain and retina during the later stages of pregnancy and early postnatal period [4]. The omega-3 fatty acids necessary for normal fetus development are provided by transfer from the mother's circulation. DHA is transported across the placenta by fatty acid-binding proteins, which are then released into the fetal circulation, then transferred to the liver where they are esterified and re-secreted in lipoproteins [5].

Many studies show that the percentage of long-chain polyunsaturated fatty acids is higher in the fetal circulation than in the maternal circulation, this indicates that the placenta may play a role in the preferential transfer of the aforementioned acids, particularly favouring DHA [6]. The effect of DHA on fetus brain development was demonstrated in an observational study, which found that children born to women who consumed more oily marine fish during pregnancy improved motor skills, showed better social skills, higher verbal intelligence and higher social development scores at eight years of age [7]. Another study using magnetic resonance imaging by Ogundipe et al. found that consuming 300 mg/d of DHA orally during the third trimester of pregnancy correlates positively with brain volume in infants [8].

Available clinical evidence suggests that omega-3 fatty acid supplementation may support optimal neural development in full-term infants. Elevated DHA levels at birth were associated with better child neurodevelopment. Nevertheless, mixed results from prenatal supplementation studies have led to speculation that other factors, such as socioeconomic status and lifestyle, may influence the benefits of DHA. In summary, adequate DHA intake through maternal diet or breastfeeding may offer some neuronal protection in specific groups of children, suggesting that DHA may be a modifiable risk factor for Autism Spectrum Disorders (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) [9].

The mother's role in providing omega-3 fatty acids does not end with childbirth. The intake during infancy through breastfeeding is also important. Maternal milk-derived omega-3 fatty acids may prove essential for better cognitive functioning, speech handling and improved psychosocial behavior [10]. Oddy et al. in their study showed, breastfeeding for less than 6 months was a factor indicating the presence of mental health problems [11]. Three randomized controlled trials conducted showed positive effects on children's cognitive development in women who supplemented with DHA [12-14]. However, it should be noted that in one of these studies, the benefits of supplementation during pregnancy and lactation were not sustained over the long term [14].

A mother's diet enriched with n-3 fatty acids protects newborns from stroke compared to children of mothers on a standard diet. Studies suggest that a diet enriched with omega-3 fatty acids affects the composition of fats that make up the newborn brain. With n-3 supplementation, there were no changes in the levels of inflammatory markers in the brain, and the accumulation of cytokines and chemokines induced by transient occlusion of the middle cerebral artery was reduced in young children on a diet supplemented with n-3 fatty acids, which shows that under basal conditions the effect of a diet supplemented with fatty acids from marine fish is not present under basal conditions, while their anti-inflammatory and homeostatic effects are reflected in reduced susceptibility to neonatal stroke [15]

OMEGA-3 AND BRAIN AGING

The process of brain aging is complex, consisting of several levels, starting from the subcellular level to the organ level. We can look for the beginning early in life, which accelerates as the years go by. This process can be divided into morphological and pathophysiological character. Morphologically, the brain volume decreases, the cortex thins, the white matter degrades, and the ventricular system dilates. In pathophysiology, on the other hand, nerve cells shrink, dendrites degrade and demyelinate, and metabolism slows down [15]. Studies have shown that environmental factors affect brain plasticity, synapse formation and dendrite formation [16].

Diet is one of the main factors that affect brain plasticity. Currently, although somewhat contradictory, a growing number of human and animal studies suggest that omega-3 polyunsaturated acids may exhibit beneficial effects on the brain, which is subject to aging [17]. As we age, the ability to learn and remember information becomes impaired. This is associated with a significant decline in the production of new nerve cells. Omega-3 fatty acids have beneficial effects on neurogenesis in adults. A study performed on old rats that received a diet enriched with EPA and DHA acids for 12 weeks showed that these compounds can positively act on processes related to the loss of neural tissue and the reduction of transcription factors associated with learning and memory – retinoic acid receptors and retinoid X receptors [18].

Another reason that may speak to the deterioration of brain function with age is inflammatory processes arising in neural tissue. A number of studies have shown useful effects of omega-3 fatty acids on age-related cognitive decline associated with their anti-inflammatory properties [19]. One study was conducted on old rats that had elevated concentrations of the markers of nervous system inflammation – interferon- γ and interleukin-1 β , the use of polyunsaturated fatty acid supplementation resulted in a decrease in the concentration of the aforementioned markers, which was associated with the restoration of long-term synaptic potentiation (LTP), responsible for an increase in the efficiency of synaptic conduction [20].

Another important mechanism associated with aging is the progressive accumulation of oxidative damage. Free radicals are responsible for the damage, which, once formed in the body, are not completely destroyed by endogenous defence systems [21]. Lipids are the building blocks of nerve cell membranes, their peroxidation may be a major cause in the pathogenesis of the aging process. Omega-3 fatty acids may promote the maintenance of membrane homeostasis by counteracting the modifications that occur with age, resulting in a reduction in cognitive decline [22]. One study observed improved memory abilities along with reduced lipid peroxidation in the hippocampus by administering DHA for 10 weeks in 25-month-old rats deficient in polyunsaturated fatty acids [23]. Human studies show that erythrocyte membranes from human offspring in their nineties show reduced lipid peroxidation and greater membrane integrity compared to the general population [24].

Another observational study of 1,315 women aged 65 to 80 years who did not have dementia found that participants with higher levels of polyunsaturated fatty acids in their red blood cells had significantly larger white matter and hippocampal volumes. In summary, aging is characterized by the occurrence of low-grade inflammation in nervous tissue. Particular attention should be paid to the activation of microglial cells and increased production of pro-inflammatory factors such as cytokines. The appearance of the inflammatory process is associated with a decline in cognitive functions, which directly translates into a deterioration in the quality of life and has serious socioeconomic consequences. Omega-3 fatty acids may play a significant role in the process of slowing down the development of neurodegenerative changes [25].

OMEGA-3 AND ALZHEIMER'S DISEASE

Alzheimer's disease (AD) is the leading cause of dementia in the elderly, affecting tens of millions of people worldwide. Clinically, it manifests as a gradual deterioration of the brain's cognitive functions, eventually leading to complete memory loss and personality changes. This clinical picture is due to extensive loss of neurons and synapses, especially in areas of the hippocampus and cortex. Macroscopically, Alzheimer's disease is characterized by symmetrical atrophy of the cerebral cortex, mainly in the medial temporal lobes, while sparing the primary motor, sensory and visual cortex. In addition, characteristic neuropathological features of this disease include the presence of amyloid extracellular plaques and intracellular neurofibrillary tangles.

Polyunsaturated fatty acids, which are an important building block of the brain, may show beneficial effects on AD. Several studies have shown reduced EPA and DHA content in postmortem brain tissue and serum samples of AD sufferers [26].

Individuals suffering from mild dementia due to AD show better cognitive performance when EPA and DHA supplementation is added to their diet. Amyloid plague formation results from abnormal extracellular accumulation and deposition of AB peptide, which is thought to be an early toxic event in AD pathogenesis, triggering the disease process. Physiologically, AB monomers are derived from amyloid precursor protein (APP) after its cleavage by β - and γ -secretase. DHA affects amyloid-related processes, leading to reduced Aβ production. Modifies the ratio of APP processing by the amyloidogenic and non-amyloidogenic pathway. Inhibits the activity of β - and γ -secretase enzymes, both directly and by regulating the intracellular transport of β-secretase BACE-1 and the connection of presenilin 1 (PS1) to lipid raft membrane microdomains. In addition, DHA and other fatty acids with four or more double bonds, such as EPA, stimulate α-secretase activity, which promotes non-amyloidogenic APP processing [27].

Total brain A β levels, as well as amyloid pathology, depend not only on A β production, but also on transport and enzymatic degradation processes [28]. The insulin-degrading enzyme (IDE) plays a key role in the elimination of A β in brain tissue. Supplementation with DHA or EPA leads to increased IDE-dependent degradation of A β 40 in immature neuroblastoma cells. In addition, omega-3 fatty acids show beneficial effects on microglia A β 42 phagocytosis and A β clearance in the interstitial tissue, further promoting A β elimination. DHA appears to further inhibit A β aggregation in vitro and counteract A β -induced toxicity in immature neuroblastoma cells. Overall, the beneficial effects of polyunsaturated fatty acids in lowering A β levels are based not only on reducing its production, but also on stimulating elimination processes.

Observational studies seem promising in preventing cognitive decline. Providing a diet rich in omega-3 fatty acids in healthy populations without previous Alzheimer's disease or dementia suggests a potential protective effect against Alzheimer's disease. It should also be noted that the results of clinical trials, which mainly concern people with AD, in which polyunsaturated fatty acids do not show any effect. This draws particular attention to the fact that fatty acids from sea fish should be consumed before the first symptoms of AD are observed [29].

OMEGA-3 AND DRUG-RESISTANT EPILEPSY

Epilepsy is a common neurological disease characterized by recurrent episodes of seizures. These episodes result from spontaneous and rhythmic changes in neuronal electrical activity, unrelated to toxic, metabolic or infectious factors. It is estimated that between 1 and 3 percent of the population may receive a diagnosis of epilepsy during their lifetime, accounting for approximately 50 million people affected worldwide [30]. In developed countries, 50 new cases of epilepsy per 100,000 people are diagnosed each year, while in developing countries the number is between 100 and 190 new cases per 100,000 people per year [31].

Although the majority of epilepsy patients effectively control their condition with medication, about 25% to 30% of people with epilepsy do not respond positively to drug treatment [32]. Refractory epilepsy is defined as the lack of satisfactory seizure control despite the use of at least two tolerable antiepileptic drugs at appropriate doses for a sufficiently long period of time in both monotherapy and combination therapy [33].

Refractory epilepsy, also known as drug-resistant, pharmacoresistant, incurable, incapacitating or severe epilepsy [34], can be a source of concern and negatively affect the quality of life of affected individuals and their families [30] Moreover, drug-resistant epilepsy is associated with an increased risk of sudden death. The phenomenon of sudden unexpected death due to epilepsy (SUDEP) is as much as five times more common in the population of people with seizures who do not respond to medical treatment, compared to those with well-controlled epilepsy [35].

Over the past decade, researchers have conducted studies on the use of PUFA supplements in the treatment of epilepsy refractory to standard treatment, but the results have been inconsistent. Although some studies have suggested a significant reduction in seizure frequency in people taking omega-3 fatty acids [36], these results have not been confirmed by other research teams [37].

Although high doses of eicosapentaenoic acid and docosahexaenoic acid appear to be relatively safe, omega-3 PUFA compounds may at the same time reduce the tendency for platelet aggregation, which could theoretically lead to a risk of bleeding [38].

The beneficial effects of omega-3 fatty acids (n-3 PUFAs) in the treatment of epilepsy are due to their anti-stimulant and neuroprotective properties [39]. Studies in the 1980s and 1990s that showed PUFA n-3 to be effective in controlling arrhythmias prompted the hypothesis that they may also contribute to reducing seizure activity [40]. Experiments in animal models have confirmed that PUFA n-3 reduce the electrical activity of neurons, inhibit the repetitive stimulatory activity of these cells and affect the regulation of the spread of epileptic seizures [41].

The inhibitory effects of polyunsaturated fatty acids are thought to be related to partial blocking of ion channels in cell membranes, resulting in a reduced influx of positive ions, such as sodium and calcium, into the cell [39]. There is evidence supporting the hypothesis that elevated levels of omega-3 fatty acids may influence the anticonvulsant effects of a ketogenic diet [41]. The concept of this diet stems from historical observations that indicated that epileptic seizures subsided during fasting. This phenomenon was attributed to ketosis, prompting the development of a high-fat, low-carbohydrate diet, usually in a 4:1 ratio, to achieve a similar one. Although the exact mechanisms of action are not yet fully understood, the increased production of ketone bodies and changes in energy metabolism induced by this diet may have potential neuroprotective effects [42].

Omega-3 fatty acids reduce the production of reactive oxygen species, which are bio-products of energy metabolism. These substances can induce oxidative damage to membrane phospholipids, contributing to the inflammation and neurodegeneration process observed in epilepsy patients [41]. In addition, they inhibit the synthesis of cyclooxygenase-2 (COX-2), an enzyme involved in the production of pro-inflammatory substances [43].

CONCLUSIONS

Available scientific evidence suggests that supplementation or increased intake of fats from marine fish significantly improves brain function, and plays an important role in prenatal and early childhood brain development. The results also show the significant potential of polyunsaturated fatty acids as a natural therapeutic agent in the treatment of epilepsy, Alzheimer's disease and other diseases that cause progressive dementia. It should be noted, however, that additional research is needed, with the main goal of determining the optimal dosage and confirming the safety profile of omega-3 fatty acids in the long term.

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CORRESPONDING AUTHOR Bartłomiej Kusy

Medical University of Warsaw Warsaw, Poland e-mail: bartlomiej.kusy99@gmail.com

ORCID AND CONTRIBUTIONSHIP

Bartłomiej Kusy: 0009-0000-8355-2262 (A) (B) (D) (E) (F) Karolina Parzecka: 0009-0007-2284-1221 (A) Piotr Kucharczyk: 0009-0005-7382-9690 (B) Kinga Szczepanik: 0009-0007-5395-7366 (E)

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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REVIEW ARTICLE

New solutions in transplantology and graft acquisition

Katarzyna-Elżbieta Grudnik¹, Maciej Słomian¹, Małgorzata Grudnik¹, Monika Prokurat¹, Mateusz Jagielski¹, Mateusz Migas², Karolina Lau², Janusz Kasperczyk²

¹STUDENT SCIENTIFIC CIRCLE AT THE DEPARTMENT OF ENVIRONMENTAL MEDICINE AND EPIDEMIOLOGY IN ZABRZE, SILESIAN MEDICAL UNIVERSITY IN KATOWICE, FACULTY OF MEDICAL SCIENCES IN ZABRZE, ZABRZE, POLAND ²DEPARTMENT OF ENVIRONMENTAL MEDICINE AND EPIDEMIOLOGY IN ZABRZE, FACULTY OF MEDICAL SCIENCES IN ZABRZE, SILESIAN MEDICAL UNIVERSITY IN KATOWICE, ZABRZE, POLAND

ABSTRACT

In view of rapid advancements in the field of transplantology, emerging solutions in tissue procurement for transplantation became a crucial area of research. Tissue transplantation plays a notable role in improving the quality of life for patients afflicted with various ailments, and the increasing number of transplants necessitates the exploration of innovative procurement methods. This study examines a new direction in transplantology, placing focus on innovative approaches to tissue procurement and discussing the commonly used method of "ex mortuo," i.e., retrieving organs from deceased donors. Given the growing demand for organs, the paper discusses the innovative approach slowly emerging as 3D bioprinting. The paper discusses the key challenges associated with the use of this method in transplantology, including issues of biocompatibility, vascularization, and integration with the immune system. The paper also discusses the latest scientific achievements in the field, such as the first transplants of bioprinted organs, demonstrating the practical application of this technology in medicine. It is also the analysis of the ethical, social, and legal aspects related to these new solutions. The article provides a comprehensive overview of the latest trends in transplantology and presents a holistic view of the current state of knowledge and prospects for development in this pivotal area of medicine.

KEY WORDS: transplantology, xenotransplantology, 3D bioprinting, biotechnology

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INTRODUCTION

Transplantation is a complex process involving the transfer of cells, tissues, and organs from one organism to another and stands as one of the most effective therapies for patients facing unrepairable failure of vital organs [1]. In recent decades, there has been dynamic development in the field of transplantology, contributing to the improvement of patients' quality of life but also presenting new challenges associated with organ procurement.

Despite medical advances, the growing deficit in transplant availability has become a key issue in contemporary transplantology [2, 3]. Statistical data indicate an increasing disparity between the number of patients awaiting transplantation and the available pool of potential donors. To address these challenges, experts from various medical fields are seeking innovative solutions in organ procurement. Exploration of novel methods and technologies, such as xenotransplantation, 3D bioprinting, or the use of artificial intelligence, has become a pivotal area of research to address this complex problem.

AIM

The purpose of this paper is to review the problems of obtaining cells, tissues and organs for transplantation, to analyze the new method of obtaining transplantation materials that is 3D bioprinting, and to evaluate the ethical aspects, potential profits and risks of this process.

REVIEW

TRANSPLANTOLOGY - CURRENT STATE

Statistical data on organ transplants serve as an indicator of the challenges currently faced by this medical field. The number of patients awaiting transplants significantly exceeds the available pool of donors, which highlights the urgent need for effective strategies development to increase organ availability.

According to data published on the Statistica platform in 2022, 157,494 organ transplants were performed worldwide, representing an increase of 27,813 transplants compared to 2021 [2].
In Poland, as per data available, in 2023 there were 523 deceased donors whose organs were suitable for transplantation, along with 94 living donors [3]. The number of essential tissue transplants performed that year was 1,746, with 20,874 individuals on the waiting list. An analysis of these data shows that in Poland, about 8% of those in need receive an organ for transplantation. Despite a demonstrated increase in the number of transplants performed in Poland, with a rise of 730 procedures between 2007 (922 transplants) and 2023 (1,652 transplants), the number of recipients still exceeds the number of donors.

These presented numbers unequivocally underscore the cruciality of the ongoing development in the field of transplantology and the necessity of exploring new sources for organ and tissue procurement.

HISTORY OF TRANSPLANTOLOGY

Transplantation has a rich history with roots in distant eras, although today it is mainly associated with advances in modern medicine.

Archaeologists have unearthed ancient Egyptian surgical techniques in papyrus scrolls, dating as far back as 2000 years BC considered the earliest attempts at transplants [4].

Similar achievements were noted in ancient Indian and Chinese civilizations, where artifacts indicate pioneering attempts at tissue and organ transplantation [5]. Dates around 600 BC, based on archaeological findings, suggest that in ancient India, the first attempts at skin grafting were made. These ancient experiments undeniably contributed to the development of the medical field, uncovering new possibilities and raising awareness about what was feasible in the realm of surgical interventions. Attempts at transplants persisted in medical awareness for centuries. However, during the medieval and Renaissance periods, this knowledge was overshadowed by the lack of precise anesthesia methods and a limited understanding of the immune system, impeding progress in the field.

The 19th century brought some advancements, but it was the 20th century that became truly a breakthrough for transplantology. In 1902, French surgeon Alexis Carrel successfully performed the first vascular transplants, earning him the Nobel Prize [4].

The first attempts at xenotransplantation were described in scientific literature in 1905. However, interest in animal transplantology waned due to the discovery of immunological barriers related to organ rejection [4]. A revival of research in this area became possible with the introduction of immunosuppressive drugs, opening a new chapter in the history of xenotransplantology. After World War II, the development of immunosuppression, or agents inhibiting immune reactions, opened new possibilities in the field of transplants. In 1954, Dr. Joseph Murray conducted the first successful kidney transplant between twins [6]. Over the subsequent decades, the scope of transplantation expanded to various organs, from the liver to the heart.

Modern transplantology is a field which dynamically evolves. Technologies such as xenotransplantation (organ transplantation from animals) and tissue engineering open new horizons [7, 8, 9]. Despite challenges related to a shortage of suitable donors, transplantology remains an important area of medicine, which offers hope for new treatment possibilities and improvement of the quality of patients' lives.

CURRENT METHODS OF ORGAN PROCUREMENT

Nowadays, the primary sources of organ procurement involve donations from living donors or post-mortem transplants [10]. Two prevalent donor selection systems exist globally, namely the French opt-out model and the American-Canadian opt-in model [11].

The first, based on the presumption of consent [11], implies that organs are retrieved from a deceased person only if they did not express opposition during their lifetime. Individuals who object to organ retrieval after death are required to report this stance in a specified manner, in accordance with the laws of the respective country. This model is enforced in various countries, including France, Austria, Finland, Belgium, and Poland.

The opt-in model requires obtaining the patient's consent for organ or tissue retrieval after death [11]. Typically, this consent is formally expressed through written statements, such as a donor card carried by the patient. In the absence of such a document, non-consent does not automatically hinder organ transplantation; there is a possibility to determine the deceased's actual position or to make the procedure contingent upon obtaining the consent of the closest family members. According to information published on the European Parliament's website, such legal regulations have been introduced, for example, in Cyprus, Denmark, and Germany. All these countries, except for Germany and Ireland, have also implemented official donor registries.

Currently, standard methods of organ procurement not only require an understanding of the technological aspects of these procedures but also consideration of the ethical implications. The processes of acquiring organs and tissues for transplantation raise fundamental questions about individual autonomy, respect for human life, and a societal approach to medical issues. At the same time, the global demand for transplants continues to increase medical advancements and rising life expectancy.

CHALLENGES ASSOCIATED WITH CURRENT METHODS

Currently, there are several challenges and issues associated with the field of transplantology that require attention and the search for innovative solutions.

This field presents ethical dilemmas related to organ retrieval from donors, both deceased and living. The focus should be on ensuring adequate ethical standards, respecting patient autonomy, and minimizing risks to donors. In addition to the tissue procurement issues described above, there are also medical challenges.

One of the main problems is matching the donor to the recipient based on tissue compatibility [12]. The highest laboratory standards will increase the chances of a successful transplant. However, compatibility alone is not sufficient. It is important to pay attention to the selection of the size of the organ according to the needs of the individual [13]. Pediatric patients constitute a special group that particularly requires organs of appropriate size, presenting a unique challenge, especially for organs with limited availability.

It is also worth emphasizing that the development of modern immunosuppression methods, surgical techniques, and progress in cell and genetic research open new perspectives but concomitantly generate new challenges and questions related to the safety and effectiveness of procedures. Therefore, further research, technological innovations, and international collaboration are crucial to effectively address current challenges and improve the efficiency of transplant procedures.

NEW DIRECTIONS IN PROCURING TRANSPLANT MATERIAL – 3D BIOPRINTING

3D bioprinting, as a revolutionary technology in the field of medicine, opens new perspectives in organ procurement for transplantation [14]. This method relies on an advanced process that integrates cells, growth factors, and biomaterials to create precise structures resembling natural tissues. The use of special materials called bioinks, containing live cells and carriers, allows for the layer-by-layer deposition of material and the creation of complex structures.

THE PROCESS OF 3D BIOPRINTING

The process of 3D bioprinting consists of three key stages: pre-bioprinting, bioprinting, and post-bio-

printing. Each of these stages plays an important role in creating functional and biocompatible tissue structures ready for transplantation.

Pre-bioprinting is a key for obtaining precise models and selecting appropriate materials [15]. The initial step involves obtaining a biopsy of the organ to be reconstructed. Technologies such as computed tomography (CT) and magnetic resonance imaging (MRI) enable the acquisition of detailed images of tissue structure. Using tomographic reconstruction, the obtained images are transformed into 3D models, which form the basis for further bioprinting processes.

The next step is isolating cells from the obtained biopsy and multiplying them. Then, they are mixed with the appropriate material, providing nutrients necessary to keep the cells alive. The second stage, bioprinting, involves placing a fluid mixture of cells, matrix, and nutrients called bioinks into the printer cartridge [15]. Based on medical scans of patients, it is determined where to precisely place the bioprinted tissue precursor. During the bioprinting process, the precursor tissue matures, and the cells merge into a three-dimensional structure that mimics the original tissue. Various methods, such as magnetic 3D bioprinting, photolithography, stereolithography, or direct cell extrusion, are used in 3D bioprinting to manufacture biological constructs. Ensuring the stability and viability of cells during the manufacturing process, especially in creating more complex structures like organs, is a key challenge.

The final stage, post-bioprinting, focuses on maintaining the mechanical integrity and functionality of the printed 3D object [15]. To achieve this, mechanical and chemical stimulation sending signals to cells to control tissue remodeling and growth is necessary. Bioreactor technologies enable rapid tissue maturation, vascularization, and enhance the transplant's survival capability. Bioreactors provide convective transport of nutrients, create microgravity environments, and allow for pressure regulation inside the model. The post-bioprinting process has a decisive impact on the final stability and functionality of the bioprinted object, making it ready for potential transplantation.

SAMPLE STRUCTURES FROM 3D BIOPRINTING

3D bioprinting, as a modern technology, plays a notable role in producing various organs and tissues, opening new horizons in transplantology.

In medical practice, 3D bioprinting has already been successfully utilized for the production of 2D tissues, such as skin, and tubular organs like blood vessels, trachea, and urethras [14, 17, 18, 19]. While some successes have been achieved, challenges persist in accurately reproducing the structure of the epidermal layer in the skin, ensuring protection against immunological rejection of the graft, and maintaining high standards of execution to preserve the functionality of tubular tissues. This is crucial for reducing the risk of phenomena such as stenosis or thrombosis, which is a foundation to the effectiveness of transplants.

Scientists have achieved no less success in creating more advanced structures such as non-tubular hollow organs like the urinary bladder [19]. Organs with such structures represent another level of complexity that can be created using 3D bioprinters. Creating a fully functional three-dimensional structure of an organ that ensures proper urine voiding requires precision and complex interactions with other systems in the body.

Solid organs like the kidney pose the most challenging task for scientists so far [21]. Achieving an organ structure that corresponds to biological complexity, as well as ensuring adequate vascularization and innervation, presents key challenges. Issues related to immunological rejection and long-term functionality require special attention.

Although the heart, as the most complex organ, remains beyond the reach of current capabilities, researchers at Tel Aviv University have made a break-through by 3D printing a rabbit-sized heart using human cells [22, 23]. While the printed heart does not beat, it represents a promising step towards new methods of treating heart diseases.

As 3D bioprinting technology advances, it is necessary to approach each type of tissue with an individual strategy, considering its biological specificity. Continuous research and adaptation of solutions are essential to counter potential complications and adapt to advancing scientific and technological knowledge. The quality of printed models remains an issue to be addressed, particularly in terms of their comparison with a living organism. Furthermore, additional research and technological development are needed for bioprinting to replace animals in clinical studies.

ISSUES SURROUNDING THE USE OF 3D BIOPRINTING IN TRANSPLANTATION

The introduction of 3D bioprinting into the field of transplantology brings revolutionary perspectives but also presents a series of challenges for researchers, doctors, and medical institutions.

The first key obstacle involves ensuring adequate networking mechanisms for materials that facilitate the embedding process in bioprinters [14]. These materials must be both printable for precise structure creation and biocompatible for long-term use in transplants. The diversity of cells, varying in size and shape, poses a challenge in controlling the printing process. Materials need to be tailored to different cell types, and their characteristics, such as size and shape, must be considered in the construction process. Nanoscale features like ridges and grooves additionally impact cell adhesion, proliferation, and morphology. Achieving short-term stability is crucial for maintaining the initial mechanical properties of tissue structures. However, these constructions must also undergo controlled degradation, enabling natural remodeling as 3D bioprinted tissues develop in vivo. 3D bioprinting in transplantology must address issues related to controlling the cellular microenvironment, precise construction, and maintaining structural stability to create effective and long-term functioning organs for transplantation.

Another equally important aspect is the precise reproduction of the physiological state of cells in vivo, which is crucial for preserving their function after transplantation [14]. Control over cell proliferation poses another challenge, where too little can lead to the loss of construct viability, and too much can result in excessive proliferation or apoptosis. The proliferation time of cells is significant for both the initial colonization of the construct and the long-term tissue homeostasis. This issue requires precise regulation of the proliferation rate, achievable through various methods such as viral transfection or the use of small molecules.

The potential rejection of transplanted constructs by the host's immune system is an obstacle that researchers can overcome through the use of autologous cell sources or tolerance induction strategies [14]. In cases of diseases or disorders preventing invasive surgical procedures, as well as when isolated cells do not fulfill desired functions, the use of stem cells becomes a promising alternative. Cells of this type, especially embryonic and induced pluripotent stem cells, show potential for self-renewal.

The sizes and complexity of the organ model structure for transplantation pose a challenge in the 3D bioprinting method [24]. The heart represents one of the largest technical problems in achieving the synchronization of heart chamber movements. Ensuring rhythmic heart function without the risk of thrombosis and heart failure is a significant challenge. The precise control of each cell and the appropriate density of blood vessels in the heart structure are crucial. Disturbances in movement synchronization can lead to irregular heart rhythm, affecting its performance. Bioprinted tissues are subject to the risk of immunological rejection, similar to traditional transplants. It is necessary to construct structures that not only minimize immune reactions but also ensure compatibility with the recipient's body [14, 25]. Therefore, proper modulation of the immune system becomes a key aspect in 3D bioprinting.

The introduction of 3D bioprinting into transplantology is not only a step into the future but also a challenge that requires the collaboration of scientists, doctors, and funding institutions to effectively overcome technical, physiological, and financial obstacles.

DISCUSSION

The overview of the presented information on new solutions in transplantology and organ procurement reveals the dynamic development of this branch of medicine while shedding light on existing challenges [5].

The positive effects of advancements in transplantology can be observed, open perspectives for more effective treatment of diseases involving the failure of vital organs and beyond. The mentioned 3D bioprinting method seems to be a promising alternative to traditional transplants, which bring hope for increased organ and tissue availability for patients [15].

The most significant ethical issue concerning the use of the described method is the costs associated with research and production, which may result in limited accessibility for the broader community. Consequently, there is a risk that modern treatment methods will become available primarily to individuals with higher socioeconomic status. It is worth considering what steps should be taken to ensure fair access to transplants for different social groups. A less-discussed issue at the current research stage but equally significant is that research on 3D bioprinting brings challenges related to the use of biological materials and patient safety. Striking a balance between technological progress and ethical standards becomes a key challenge, requiring transparency, fairness, and responsibility in the research process. In the long term, the success of 3D bioprinting in transplantology will depend not only on the clinical effectiveness of the products but also on skillfully addressing these ethical challenges [8, 10].

The frequently emphasized issue in this paper is the increasing number of patients awaiting transplants, which requires not only modern technological solutions but also a focus on public education, the elimination of cultural barriers, and the adaptation of the law to current realities. The presumed consent model appears as a potential compromise, respecting individual autonomy while stimulating the field's development. However, there is a need to increase public awareness in this regard [22].

In summary, despite challenges related to donor shortages, modern approaches to transplantology offer hope for a future where innovative technologies, new procurement methods, and societal awareness will enable more effective life-saving and improve the quality of medical care. Key to this will be the continuation of scientific research, interdisciplinary collaboration, and active societal engagement in transplant-related processes [25].

CONCLUSIONS

Transplantology is a dynamically evolving field of medicine. It offers hope for effective therapy for many diseases, especially those characterized by the failure of vital organs.

Despite numerous benefits resulting from advancements in this medical field, the most significant challenge remains the process of obtaining transplant materials. The current number of patients awaiting a transplant far exceeds the availability of potential donors. To adress this challenge, it is essential to increase public awareness through education, social campaigns, and encourage consent to organ donation during one's lifetime. Continuing scientific research, developing new methods and technologies, and adapting the law to contemporary needs appear valuable. This will enable the creation of more efficient and sustainable systems for organ procurement, storage, matching, and transplantation.

Looking into the future of transplantology, emerging solutions such as the 3D bioprinting described in this paper seem to be a promising alternative to ex mortuo transplants, bringing hope for improved organ availability. The development and standardization of modern solutions hold promise for facilitating life-saving procedures and improving the quality of life for patients who would otherwise be limited to symptomatic treatment.

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CORRESPONDING AUTHOR

Katarzyna Elżbieta Grudnik

Silesian Medical University in Katowice, Faculty of Medical Sciences in Zabrze, Student Scientific Circle at the Department of Environmental Medicine and Epidemiology in Zabrze, Poland e-mail: katarzyna.grudnik15@gmail.com

ORCID AND CONTRIBUTIONSHIP

Katarzyna Elżbieta Grudnik: 0009-0006-1583-0041 A B D Maciej Słomian: 0009-0008-9060-2860 A B D Małgorzata Grudnik: 0009-0000-4959-8830 A B D Monika Prokurat: 0009-0001-3924-9327 A B D Mateusz Jagielski: 0009-0004-2482-7253 A B D Mateusz Migas: 0009-0001-0274-7832 A B D Karolina Lau: 0000-0002-8654-0301 E F Janusz Kasperczyk: 0000-0002-6945-1200 E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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SHORT COMMUNICATION

CONTENTS 🔁

Surgical methods of managing the upper lip frenulum – a literature review

Agnieszka Rolek¹, Piotr Pławecki²

¹PRIVATE DENTAL PRACTICE- AGNIESZKA ROLEK, WROCLAW, POLAND ²DEPARTMENT OF CRANIO-MAXILLO-FACIAL SURGERY, PROVINCIAL SPECIALIST HOSPITAL NAMED AFTER ST. BARBARA — TRAUMA CENTER, SOSNOWIEC, POLAND

ABSTRACT

The upper lip frenulum with an overgrown structure or improper attachment is a common cause of hygienic, orthodontic, or prosthetic issues that prompt surgical intervention. The following article presents the surgical methods for the elimination of the overgrown frenulum, discussing and comparing them. Commonly used and described in the literature methods for surgical correction of the upper lip frenulum include frenulectomy, frenuloplasty, and laser excision of the frenulum. The article presents, discusses, and compares the methods of surgical correction of the upper lip frenulum, highlighting the advantages and disadvantages of each procedure. According to researchers, when comparing methods using a scalpel, Z-frenuloplasty is characterized by the lowest recurrence rate and consequently the highest effectiveness in eliminating the problem of an overgrown frenulum. The article also outlines several advantages of using laser methods (diode laser, CO₂ laser), such as the elimination of bleeding, reduced postoperative pain reported by patients, and the lack of need for suturing the postoperative wound. Each case depends on a thorough clinical examination of the patient, identifying the specific problem, making an accurate diagnosis, and ultimately adjusting the choice of one of the methods to the individual conditions and medical issue of the patient.

KEY WORDS: frenulum, upper-lip, frenulectomy

INTRODUCTION

The upper lip frenulum is a thin, vertical band of soft tissue located on the vestibular side of the maxilla. It runs from the inner surface of the upper lip to the area between the central incisors of the maxilla. It is composed of oral mucosa, connective tissue, and muscle fibers [1]. Due to its structure and the variability of its attachment within the process, the upper lip frenulum is often the cause of complications in orthodontic or prosthetic aspects, necessitating its surgical correction. Depending on the location of the attachment, four types of frenulum attachments are distinguished [2, 3]:

- mucosal,
- gingival,
- papillary,
- penetrating the papilla.

Clinically, the last two (papillary and penetrating the papilla) are considered abnormal [9], causing orthodontic, functional, prosthetic, or periodontological complications and are indications for surgical treatment to increase the mobility of the upper lip, avoid displacement of prosthetic supplements, prevent food retention, or eliminate diastema. An intraoral examination of the patient eshould also include pulling the upper lip to diagnose "pull syndrome," which manifests as blanching of the free and attached mucosa. This condition carries the risk of developing gingival recession in the future [4]. Treatment can include:

- frenulectomy complete removal of the upper lip frenulum,
- frenuloplasty removal of fibers with the movement of the resulting flaps and suturing of the wound
- laser frenulum removal [1, 3].

AIM

The purpose of the study was to present and debate the methods of surgical correction of the upper lip frenulum presented in the literature. Based on the literature, surgical methods of dealing with the upper lip frenulum were identified and presented [1].

REVIEW AND DISCUSSION

FRENULECTOMY

A simple, radical removal of the upper lip frenulum by making a lens-shaped incision in the mucous membrane, connective tissue, and muscle attachments, leaving only the periosteum to limit wound healing complications [1]. This method can be used in conjunction with healing by secondary intention – when no sutures are used to close it, as well as with wound suturing. Both procedures require the patient to perform logopedic exercises of the lip and its massage to achieve the desired therapeutic effect. The method of frenulectomy, especially assuming omission of wound suturing, carries disadvantages in the form of increased risk of bleeding and increased postoperative pain [5].

Z-FRENULOPLASTY

A plastic surgery involving the making of two oblique, 60-degree angle cuts relative to the median line after the removal of the frenulum and moving them to achieve primary wound closure, described as a technique limiting the risk of scarring along the main axis of the frenulum [1]. Changing the tension from vertical to almost horizontal has shown in clinical studies a relatively long-lasting therapeutic effect and low risk of recurrence [6]. This technique is particularly indicated when hypertrophy of the frenulum with a low attachment is observed, and when the eruption of lateral incisors did not reduce the diastema [7].

V-FRENULOPLASTY

Removal of the upper lip frenulum along with the displacement of its attachments apically, allowing at the same time, a significant deepening of the vestibule of the oral cavity. The procedure in this case involves a "V" shaped incision followed by detachment and movement of the lower apex of the triangle into the floor of the vestibule by suturing it to the periosteum. Indications for this technique include overgrowth of the frenulum with a massive attachment on the lip side and is described as more predictable than simple frenulum removal [1]. The disadvantage of V-frenuloplasty is wound healing by granulation, which is associated with pain and discomfort for the patient, the risk of increased intraoperative or postoperative bleeding, and scarring.

LASER FRENULUM REMOVAL

Lasers used in frenulectomy techniques reduce intraoperative bleeding, allow for the use of less anesthetic and usually heal with minimal discomfort [1, 9]. Compared to classic methods, the use of a diode or CO₂ laser practically eliminates intraoperative bleeding, which is associated with tissue coagulation. This leads specialists to consider the laser technique in patients with coagulation disorders. There is also reduced need for surgical suturing of tissues [8, 9] which usually shortens the procedure. Studies have shown that patients who underwent frenulum surgery using a laser took fewer painkillers in the postoperative period [9].

CONCLUSIONS

Diagnosing an abnormal attachment of the upper lip frenulum always requires a thorough analysis of the clinical situation and a general patient interview to accurately tailor the surgical method to the individual. Research shows that among methods using a scalpel, Z-frenuloplasty is characterized by the greatest effectiveness, the lowest recurrence rate, and a minimal potential for scarring. Compared to all classical methods, laser frenulum removal reduces the risk of bleeding, eliminates the need for suturing the wound, and improves the patient's subjective postoperative feelings. Each qualification for a frenulectomy procedure should be preceded by a thorough clinical analysis, and the choice of method should be tailored to the individual needs of the patient.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Agnieszka Rolek Private Dental Practice- Agnieszka Rolek Wroclaw, Poland e-mail: aga.rolek@gmail.com

ORCID AND CONTRIBUTIONSHIP

Agnieszka Rolek: 0009-0007-2880-2055 A B D E F Piotr Pławecki: 0000-0003-2550-8452 A B D E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

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