ORIGINAL ARTICLE

CONTENTS

The role of health monitoring technologies in optimising athletes' self-regulation

Roman V. Gakh[1], Larisa Ya. Fedoniuk[2], Oksana Ye. Furman[1], Vira O. Kramchenkova[3], Oleksiy I. Kuznetsov[3]

[1]WEST UKRAINIAN NATIONAL UNIVERSITY, TERNOPIL, UKRAINE

[2]I. HORBACHEVSKY TERNOPIL NATIONAL MEDICAL UNIVERSITY, TERNOPIL, UKRAINE

[3]KHARKIV NATIONAL PEDAGOGICAL UNIVERSITY, KHARKIV, UKRAINE

ABSTRACT

Aim: To analyse current approaches to monitoring sports performance and health of athletes by developing an intelligent system that combines wearable devices, cloud computing and deep learning methods.

Materials and Methods: The paper analyses related literature in sports medicine, informatics and artificial intelligence. The work is based on studying the effectiveness of devices such as Fitbit Charge 5, Garmin Venu 2, Samsung Galaxy Watch 4, and Oura Ring Gen 3.

Results: Showed that such systems provide high accuracy in predicting athletes' health status. The presented models allow real-time tracking of physiological parameters, analysing the data and generating health reports for prompt adjustment of the training process. These devices enable systematic monitoring of various indicators, such as heart rate, stress level, sleep quality and overall physical activity. Reading these indicators allows athletes to receive objective information about their condition. This, in turn, contributes to more effective training planning, recovery and injury prevention.

Conclusions: Integrating wearables, cloud computing, and deep learning methods presented on the latest devices is a promising approach to sports health monitoring. The analysed devices can improve athletes' performance, prevent injuries and optimise training programmes.

KEY WORDS: wearable devices, mobile applications, analytics, self-regulation, sports performance, psychological well-being

Wiad Lek. 2025;78(8):1544-1553. doi: 10.36740/WLek/209507 DOI

INTRODUCTION

In today's world, where technological advancements are covering all areas of life, sport is no exception. Technology has become an integral part of everyday practice, enabling athletes, coaches and even amateurs to improve their performance and maintain their health. Smartwatches, fitness trackers, and sleep and physical activity monitoring apps are just a few examples of how technology is being integrated into sports. Their role goes far beyond convenience, as they have an impact on optimising training, developing athletes' self-regulation and increasing the efficiency of goal achievement [1].

The relevance of the topic lies in the fact that the role of technology in sports is becoming increasingly important, especially in the context of professional and amateur training. The growing popularity of fitness apps and health monitoring platforms such as Strava, Fitbit, and Garmin Connect indicates a change in approaches to maintaining physical activity.

Such tools allow athletes to track key parameters, including heart rate, sleep duration and quality, number of steps, calories burned, and other metrics that determine the overall health of the body.

Considerable attention is paid to personalised approaches, where data obtained through technology is analysed and used to create individual training programmes [1, 2]. In this context, the importance of innovative solutions becomes obvious: they help athletes develop self-regulation skills, which is key to achieving long-term results and maintaining health.

Despite the fact that this topic has been studied, there are still research gaps. Despite the wide range of research on the use of technology in sports, many questions remain open. Most studies focus on the physical aspects of performance, while the psychological impact of monitoring technologies is often overlooked. The impact of such tools on athletes' motivation, emotional state, and cognitive processes has not been sufficiently studied. In addition, it is important to assess the long-term effect of such technologies, in particular, their ability to promote the development of self-regulation in different groups of athletes, from beginners to professionals.

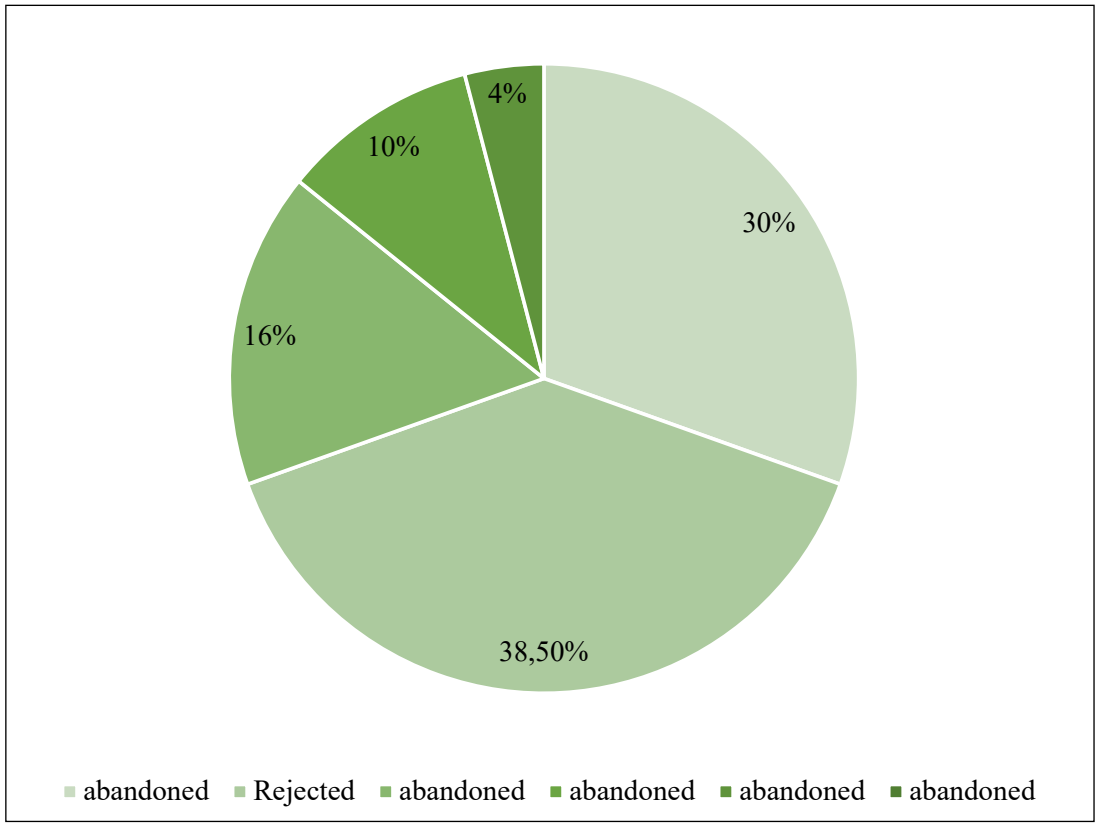

Fig. 1. Visualisation of publication selection according to PRISMA recommendations
Picture taken by the authors

AIM

To analyse current approaches to monitoring sports performance and health of athletes by developing an intelligent system that combines wearable devices, cloud computing and deep learning methods.

MATERIALS AND METHODS

The hypothesis of the study is that the use of health monitoring technologies, such as Fitbit Charge 5, Garmin Venu 2, Samsung Galaxy Watch 4, and Oura Ring Gen 3, increases the effectiveness of athletes' self-regulation, which in turn helps to improve their sports performance and reduce the risk of injury.

The study used a comprehensive approach that involved bibliometric and documentary analysis methods. The bibliometric analysis allowed us to systematise and evaluate scientific publications on the impact of health monitoring technologies on athletes' self-regulation. The documentary analysis included a review of regulations, reports and recommendations related to the use of modern wearable devices and mobile applications in sports practice.

DATABASES FOR SEARCHING PUBLICATIONS

For the analysis, we used leading scientometric databases, such as: PubMed is a specialised platform for searching for publications in the field of medicine and sports. It was chosen because of its reputation and a large number of articles on clinical and sports research. Scopus is a database with interdisciplinary publications that allows for bibliometric analysis. It was used to search for articles on computer science, sports science and technology. Web of Science is a database that provides access to high-quality scientific sources and enables citation analysis. IEEE Xplore is a specialised platform for technology research that contains articles on health monitoring devices and artificial intelligence. These databases were selected because of their ability to provide access to up-to-date and reliable information in the relevant fields of study.

SELECTION OF SCIENTIFIC PUBLICATIONS

The selection of publications was carried out in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The process included several stages: formulation of search queries using the following keywords: wearable devices, mobile applications, analytics, self-regulation, sports performance, and psychological well-being (Fig. 1).

INCLUSION CRITERIA

Publications related to the impact of technology on athletes' self-regulation. Works published in English from 2019 to 2024. Empirical studies describing the im-

Table 1. Criteria for including related publications

Inclusion criteria	Rationale	Publications that meet the criterion
The impact of technology on athletes' self-regulation	Research should focus on the impact of wearable devices and mobile applications on physical condition or behaviour	All publications in the list
English language of publication	To ensure accessibility and standardisation of results	All publications in the list
Publications 2019-2024	Ensuring the relevance of the research results	All publications in the list
Empirical research	Publications should contain practical results, not just theoretical generalisations	All publications in the list

Source: compiled by the authors of this study

Table 2. The most effective wearable devices for athletes' self-regulation

Model	Key functionality
Apple Watch Series 8	ECG, heart rate, sleep tracking, GPS
Fitbit Charge 5	Heart rate, GPS, Sleep tracking, Stress
Garmin Venu 2	Heart rate, GPS, Sleep tracking, Music
Samsung Galaxy Watch 4	ECG, heart rate, GPS, pulse oximeter
Oura Ring Gen 3	Heart rate, sleep tracking, temperature

Source: compiled by the authors of this study

pact of wearable devices or mobile applications on the physical condition and behaviour of athletes (Table 1).

EXCLUSION CRITERIA

Publications that describe general aspects of technology without their relation to sports. Articles without access to the full text. After filtering, 50 works that met the criteria remained.

ANALYSIS OF THE DATA OBTAINED

The data obtained were systematised into categories (Fig. 2).

The data were analysed using text processing software (NVivo) and bibliometric analysis (VOSviewer). This allowed us to identify the main trends, research gaps and areas for further work.

Thus, the chosen approach allowed us to obtain a systematic picture of the role of technology in monitoring the health of athletes and its impact on optimising self-regulation.

RESULTS

The use of health monitoring technologies is key to optimising athletic performance and supporting athletes' self-regulation. Modern wearable sensors and intelligent analysis systems allow you to track physical parameters and provide personalised recommendations to improve self-management. The latest technologies, such as Bi-STAN, DST-LSTM and GRU, provide more accurate recognition of activity types, facilitating better adaptation of training plans.

Innovative devices, such as brain-computer interfaces (BCIs), achieve 98.2% accuracy in determining motor representations, helping athletes to adapt their workload and avoid injury [2]. CNN-LSTM models allow for efficient classification of sports activity, optimising the use of wearable device resources [3]. Such systems collect data on physiological indicators, analyse them in real-time, and generate recommendations available through a mobile application.

Wearable devices are becoming an integral part of the training process due to their ability to provide real-time monitoring of health indicators. Table 2 shows the most effective device models:

Among the latest devices, brain-computer interfaces (BCI) are innovative. They analyse ECG data to determine motor representations with 98.2% accuracy. Such a system can help increase athletes' awareness of the state of their nervous system, affecting their ability to self-regulate.

Various deep learning models also allow for efficient classification of sports activity, using statistical feature extraction to distinguish between static and dynamic states, reducing computational costs and optimising wearable devices [4].

When researching health monitoring technologies, protocols aimed at analysing performance in different settings should be conducted, as they can improve self-regulation, although their use is limited by the small scale of the datasets [5].

Table 3. The process of processing data received on wearable devices

Process	Explanation
Filtering	This stage removes noise and unwanted signals from the sensor data. The use of various filters (low-pass, high-pass, bandpass) helps to cleanse the data from noise, which improves its quality.
Smoothing	This technique removes sharp fluctuations in the data by applying a moving average filter. Smoothing helps reduce the impact of noise, making the data more stable and understandable.
Selection of features	At this stage, significant features of the data are identified that can contribute to the prediction of the target variables. Thanks to these processing steps, we get a clean and normalised dataset ready for further work in machine learning models. The quality of pre-processing directly affects the accuracy and reliability of the final model.

Source: compiled by the authors of this study

Table 4. The process of protecting data received on wearable devices

Protection of personal data	Process
De-identification	Using strategies that make it impossible to identify individuals by removing or modifying unique identifiers such as names and contact information.
Data security	Focusing on security issues to protect athletes' medical data from leaks and unauthorised access.
Encryption	Implementation of encryption mechanisms (AES) to ensure secure data transmission between wearable devices, communication gateways and cloud servers, preventing data interception.
Access control	Implementing strict access controls that restrict access to data to authorised personnel only, preventing data manipulation.
Data leakage protocols	Develop protocols to respond to potential data breaches, including notification procedures and recovery plans. This helps maintain the confidentiality and integrity of athletes' medical data.

Source: compiled by the authors of this study

Visual methods, such as Inturi's approach to detecting falls without wearable devices, provide new opportunities to improve safety and adapt athletes to different environments. The latest technologies offer multifunctional systems for fusing data from different sensors that can support athletes in monitoring complex parameters of their condition.

In general, the latest technologies, such as Bi-STAN, DST-LSTM and GRU, provide more accurate activity recognition, facilitating better adaptation of training plans. For example, using CNN-LSTM models with self-regulation for activity analysis allows for personalised recommendations for athletes based on their unique conditions [6]. Thus, research shows that innovative health monitoring technologies improve sports performance and create conditions for more conscious self-regulation, helping athletes avoid overload and injury.

Effective health monitoring is key to maintaining high performance and preventing injuries in modern sports. Athletes increasingly use technologies that monitor physiological parameters such as heart rate, body temperature and activity level. Wearable technologies are increasingly important in sports training, allowing real-time health data. Improving athletes' self-regulation levels largely depends on accurately collecting and analysing information from these devices. This requires the implementation of modern data processing methods, in particular, machine learning algorithms. Innovative gadgets based on cloud platforms and artificial intelligence cannot only track physical indicators but also predict possible risks during training or competitions [7]. Such systems have two main parts: a wearable device and a cloud server. The device records key physiological indicators during physical activity, and the server processes them using complex algorithms. Convolutional neural networks (CNN) are used to analyse spatial characteristics, and LSTM networks estimate dynamics over time to achieve maximum accuracy in predictions. The processed data is transmitted to the athlete via a mobile application in the form of a report on his physical condition.

This helps you quickly respond to changes, adjust training intensity, and prevent potential injuries. The report may also include recommendations for recovery, load optimisation, or a temporary break from training.

Data preprocessing plays a key role in this process. It ensures data quality and accuracy, which is the basis for further analysis. Preprocessing includes noise removal,

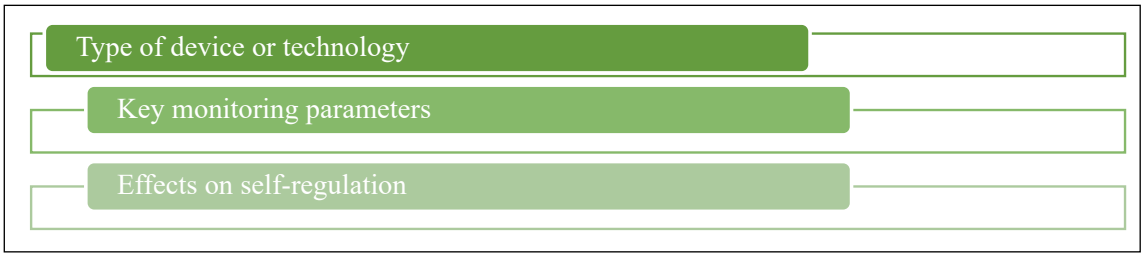

Fig. 2. Categories of data obtained *Picture taken by the authors*

Fig. 3. Smart gadgets for sports

normalisation, and data preparation, which significantly increases the efficiency of machine learning algorithms. Accordingly, the role of health monitoring technologies in optimising athletes' self-regulation and the integration of health monitoring technologies into the training process of athletes not only increases the efficiency of their training, but also contributes to the preservation of physical health, which is an important aspect in achieving sporting success.

In modern sports, health monitoring technologies play a key role in optimising athletes' self-regulation, and one of the most important stages in working with data obtained from sensors is their preprocessing. This process includes several stages (Table 3).

In the process of working with athletes' medical data, we also explored methods of removing direct identifiers to protect privacy (Table 4).

When modelling an athlete's health status, health monitoring technologies use neural network architectures such as CNN (convolutional neural networks) and LSTM (long-term memory with short-term memory) with self-attention. Accordingly, the input data passes through CNN layers, which are processed using a set of filters to extract features. At this stage, the data undergoes a nonlinear activation process that generates the final result. The LSTM model plays a key role in recognizing temporal dependencies in the data, which is important for analyzing health-related indicators. The data processed using CNN and LSTM are combined and passed through an attention layer that focuses on the most significant aspects of the information. The final stage involves the work of a fully connected layer that transforms the received data into predictions about the athlete's health status [8]. This complex data processing process allows monitoring technologies to assess the athlete's physical condition and promote the development of their self-regulation skills. Thus, monitoring systems play an important role in increasing the ability of athletes to independently assess their well-being, providing accurate information about physical performance and overall condition. At the heart of such systems is using deep neural networks, particularly CNN and LSTM models, supplemented by attention mechanisms, to create more accurate predictions about health status. Researchers are actively working on implementing these models in cloud platforms, providing athletes with convenient access via mobile applications. The process includes setting up the

server infrastructure, installing the necessary software, loading the model, creating an API, and conducting comprehensive system testing. After successful testing, the model becomes available for use, allowing users to enter data and receive personalized health predictions [9]. The development of such systems requires funding to purchase wearable devices, create a cloud infrastructure, implement machine learning technologies, develop mobile interfaces, ensure cybersecurity, and regularly update. In addition, the system must be designed to easily scale, process increasing amounts of data and the number of users, integrate with modern wearable devices, and ensure stable operation of the cloud infrastructure. Integration of the system with the existing sports infrastructure is essential for its effective implementation, which includes ensuring data compatibility, API development, interoperability, user acceptance and data privacy. The experimental environment for the athlete health monitoring system consists of several components, such as wearable sensor devices, Google Cloud Platform for deployment, Compute Engine and Cloud Storage for data processing and storage (Fig. 3).

This environment ensures efficient data processing and maintains accurate predictions, critical to optimising athletes' health and performance. Modern health monitoring systems have become an important tool for improving the ability of athletes to analyse their condition independently. Innovative wearable gadgets with advanced sensors provide detailed information about physical condition, stress level and sports performance. In particular, data obtained from devices with accelerometers and gyroscopes allow for a deeper assessment of everyday activities such as running, walking or climbing. Thanks to this information, it can effectively improve the exercise technique and adjust training programs to achieve higher results.

Monitoring systems encompass diverse activities, enabling the assessment of how different factors influence physical fitness and overall health. For instance, examining actions like opening a door or drinking from a bottle can offer valuable insights for refining performance techniques. Leveraging machine learning models such as CNN-LSTM, these technologies achieve remarkable precision in identifying physical activities. This paves the way for designing personalised training programs and enhancing the efficiency of athletic performance.

Models with integrated self-focusing mechanisms demonstrate even greater efficiency in complex tasks, such as recognising and classifying sports actions. Studies show that implementing such technologies not only provides accurate control of physical condition but also helps reduce the risk of injuries, avoid overloads, and improve overall performance.

Thus, health monitoring systems have become an important part of modern training, providing coaches and athletes with tools to manage physical fitness and health better. They contribute to a more effective training organisation and achieve high results.

DISCUSSION

In modern sports, health monitoring technologies play an increasingly important role, especially in the context of self-management of recovery and self-regulation, and they are actively being researched [10-12] in contrast to the analysis of the prevalence of sleep app users. The study by Afsar et al. [13] showed that among athletes, the prevalence of sleep app users, for example, is quite low – less than 20%. In this context, the researchers analysed why so few athletes use these technologies despite their potential benefits for optimising sleep and recovery. In this context, according to Baltabay, Yazici, Sterling, and Ever [14], on the one hand, the results of longitudinal studies show that fitness apps that track physical activity are more popular. Scientists attribute this to the traditional focus on physical activity in the sports community, while sleep as a component of recovery remains underestimated. Górriz with colleges [15] attribute this to a lack of awareness of the importance of sleep for sports performance. In the context of the role of health monitoring technologies in optimising athletes' self-regulation, researchers have shown that users of sleep apps have demonstrated higher levels of self-regulation, which may indicate that those who are more interested in their recovery are more likely to seek out self-regulation tools [16]. In this context, Khater, Hadhoud, and Fayek [17] argue that self-regulation is a key factor that influences the use of monitoring technologies. Mekruksavanich and Jitpattanakul [18] explore strategies that can be applied to encourage more athletes to use apps and the features and capabilities that are most attractive to athletes. The development of apps that incorporate behavioural designs to support healthy sleep hygiene is also being actively explored [19]. From the point of view of scientists, health monitoring technologies have great potential to support athletes in their recovery and development. However, for their effective implementation, more research is needed that focuses on user motivation, app functionality, and their impact on physical and mental health. In this context, it is worth exploring what next steps can be taken to improve the use of these technologies in sports practice.

Technological advances, including artificial intelligence, big data and the Internet of Things, have changed the way people exercise. Digital platforms

and mobile apps allow people to train at home, access personalised coaching advice, and analyse their progress together in real-time. According to von Haaren-Mack, Schaefer, Pels, and Kleinert [20], smart gadgets provide athletes with data about their health status that was previously only available in the laboratory. In this context, a study by Yin, Xu, and Ren [21] shows that sleep monitoring technologies can detect the phases of deep and shallow sleep, which is important for recovery. Tools that track physical activity can signal the need to adjust loads, helping to avoid overexertion. At the same time, data analytics platforms, according to Park & Choi, provide valuable insights that help to achieve goals more effectively.

While technology offers enormous potential for sports development, there are also challenges. Pan, Brulin, and Campo [22] highlight technical issues, the need for users to adapt to new tools, and the accessibility of such solutions to a broad audience. The authors emphasise the importance of considering the dependence on technology, which can lead to decreased autonomy in decision-making and a reduction in the intuitive approach to training.

Digital innovations in sports are a significant factor in creating conditions for optimising athletes' self-regulation. Studying their impact allows us to understand better how these tools can contribute to improving physical performance and developing critical skills that allow athletes to achieve more sustainable results. Zhang, Chen, Fan, Xin, Wu, and Lv [23] analyse how technology affects these processes, what research gaps remain unresolved, and what the future holds.

The sports industry is evolving thanks to technological advances, particularly in artificial intelligence and health monitoring, which help athletes optimise training, monitor performance and prevent injury [10]. Modern wearable devices can collect data on parameters such as heart rate, energy expenditure, speed, distance covered, and sleep quality. The information collected allows athletes and coaches to closely monitor their physical condition and adjust training programs according to individual needs. In particular, machine learning algorithms analyse this data, identifying patterns that contribute to more effective organisation of training and recovery. One of the key aspects of health monitoring is the ability to predict the risk of injury. By analysing heart rate variability and other indicators, modern technologies can detect signs of overfatigue or excessive physical exertion. In their study, Yun and Choi [24] note that this approach allows athletes to react quickly and reduce the likelihood of injury.

In their opinion, self-regulation becomes more effective as athletes are able to respond to their body's signals in a timely manner. Health monitoring technologies can create personalised training programmes based on each athlete's individual characteristics, significantly increasing the effectiveness of training. The devices help to avoid overloading, which can lead to injury [25]. Thanks to real-time feedback, it becomes possible to adjust one's technique and strategy, ensuring athletes' competitiveness.

Thus, the proposed work is relevant since health monitoring technologies play an important role in optimising athletes' self-regulation. The results obtained will provide detailed information on the feasibility of implementing such technologies in sports practice, as the latest technologies open up new horizons for achieving high sports results and improving athletes' overall health.

Rapid advances in sensor technology have opened up new opportunities for the development of high-performance wearable devices used to monitor human health, including that of athletes. Given that health is a key aspect of sports activities, a variety of equipment has been developed to continuously monitor physical condition. Wearable sensors, due to their unique characteristics, have become indispensable tools in sports medicine, as they allow for the timely detection and diagnosis of health problems.

Modern technologies are significantly changing approaches to the training process, providing new opportunities for monitoring and improving athletes' physical performance. However, the importance of technology in sport is not limited to physical aspects; its impact on the psychological state, motivation and self-regulation of athletes requires more detailed study. As the study results show, technologies such as wearables, mobile applications and analytics systems open up new horizons for managing health and training performance, but their implementation is accompanied by certain challenges.

The scientific novelty of the proposed research is that despite significant progress in the use of technology, many aspects of its impact on the psychological state and quality of sleep of athletes remain insufficiently studied. Based on a literature review and a practical study of the effectiveness of wearable devices such as Fitbit Charge 5, Garmin Venu 2, Samsung Galaxy Watch 4 and Oura Ring Gen 3, the aim was to demonstrate how these tools can not only provide objective information about physical condition but also contribute to the development of psychological well-being. In the same context, Basso-Bert, Detre, Gobert, Hassanaly, and Pige describe how regular tracking of metrics such as heart rate and sleep quality can increase athletes' awareness of their needs and capabilities, which in turn can affect

their motivation and desire to reach new heights.

However, Kurkdjian emphasizes that, despite the significant benefits, it is important to consider possible disadvantages, such as information overload, which can cause stress or anxiety about personal health. This highlights the need to create guidelines for the responsible use of these technologies to reduce possible negative consequences.

The proposed study aims not only to examine the benefits of monitoring technologies, but also to investigate in detail their impact on the mental health of athletes. In this context, Sun's study supports the view that addressing these issues can significantly improve training programs and increase athlete performance, opening up new avenues for research in this area.

The rise in popularity of sleep and fitness tracking apps can be attributed to the connection between wearables and cloud-based technologies. These apps analyse sleep quality and stress levels and provide recommendations for improving fitness. A study by Cojocaru et al. [26] found that the most popular features included heart rate monitoring, sleep analysis, and stress levels. Researchers have found a relationship between athletes' self-regulation and their use of monitoring technologies. These technologies play an important role in increasing self-discipline among athletes. As Castelli and Mitchell [27] point out, these technologies allow for adjustments in training loads based on objective data such as heart rate, body temperature, and activity level. Wearables provide athletes with personalised reports that help them make informed training decisions.

The CNN and LSTM algorithms described in this paper have also been analysed by Cheung [28]. According to the author, they allow analysis of the temporal and spatial characteristics of activity, improving the accuracy of health forecasts. The collected data is transferred to cloud servers, where it is processed to identify potential risks. Brusseau, Erwin, Darst, and Pangrazi demonstrate how the system can recommend a reduction in training intensity to prevent overload. Scientists agree that the use of wearable devices improves sports performance and creates conditions for conscious self-regulation [29].

Smart technologies provide the ability to monitor indicators such as heart rate, blood pressure and body temperature, which are critical for optimising athletes' training and recovery. In their article, Beaudet and Deveaux summarise the achievements and challenges in the production of wearable sensors for health monitoring, particularly in the context of athletes' self-regulation. The authors classify wearable sensors into three main areas: biophysical tracking, biochemical monitoring, and real-time data detection. They are made of different materials and technologies, which allows them to be adapted to the specific needs of athletes. Similar studies demonstrate significant progress in this area but also point to existing challenges, such as measurement accuracy and comfort during use.

Thus, modern wearable devices create new opportunities for monitoring the physical condition of athletes, contributing to the optimisation of their self-regulation, which is an important factor in achieving high sports performance.

Innovative technologies in the field of health monitoring show great potential in improving training processes and self-monitoring of athletes [30]. The combination of wearable devices with machine learning algorithms allows not only to reduce the risk of injuries, but also to maintain high performance through personalised analysis of physical condition.

Despite the significant value of the analysis, the study has some limitations. One key factor is the time frame: the work focuses exclusively on publications published between 2019 and 2024. This limitation may result in the omission of important developments and technologies that have appeared earlier or were not included in the selected databases. Another important aspect is the language factor, as only English-language works were considered. This may make it difficult to access important studies published in different languages that could improve the overall understanding of the topic. The studies focus mainly on the impact of wearable devices and mobile applications on self-regulation, which limits the study of other technologies, such as data analysis systems or social networks, which may also have an impact on this area. The use of only four databases may reduce the quality of the review, as important studies may be available from other sources. In addition, the exclusion criteria for studies that address general technological aspects not directly related to sports may prevent the acquisition of valuable information useful for sports practice. These limitations are important to consider when interpreting the results and formulating recommendations for future research, as they may significantly affect the validity and relevance of the data obtained.

CONCLUSIONS

Monitoring athletes' health can change how we assess their physical fitness, which is critical for achieving the best results. Innovative technologies such as wearable devices, cloud solutions and machine learning algorithms provide accurate and timely information about physiological status. This allows athletes to adjust their training programs and competition schedules, reducing the risk of overload and injury. The models used for assessment demonstrate high accuracy, which surpasses many traditional methods

of predicting physical fitness. For further development of this technology, it is important to expand the database to include a variety of athletes, especially those who use gadgets to monitor their activity and sleep. This will allow for the creation of more comprehensive health monitoring solutions, taking into account individual physiological characteristics. An individual approach is key to the successful integration of monitoring systems. Considering each athlete's specific training methods and physical characteristics, recommendations can be developed that meet their personal needs. Adding real-time feedback and alerts about potential health risks can significantly improve the effectiveness of such systems. Thus, health monitoring technologies contribute to better self-monitoring of athletes and open up new opportunities for future development. They pave the way for achieving outstanding results while putting health and supporting athletes' physical and mental well-being first.

REFERENCES

1. Yeroshenko GA, Lysachenko OD, Gasiuk NV et al. Suchasni tendentsiyi u vykladanni medyko-biolohichnykh dystsyplin. [Current trends in teaching medical and biological disciplines]. Aktual'ni problemy suchasnoyi medytsyny: Visnyk Ukrayins'koyi medychnoyi stomatolohichnoyi akademiyi. 2022;22(3–4):183–186. doi:10.31718/2077-1096.22.3.4.183. (Ukrainian) DOI
2. Smith AA, Li R, Tse ZT. Reshaping healthcare with wearable biosensors. Scientific Reports. 2023;13(1):4998. doi: 10.1038/s41598-022-26951-z. DOI
3. Shapovalov YB, Bilyk ZI, Usenko SA et al. Using of personal smart tools in STEM education. In Proceedings of the 1st Symposium on Advances in Educational Technology. 2022;2:192–207. doi: 10.5220/0010929900003364. DOI
4. Patalas-Maliszewska J, Pajak I, Krutz P et al. Inertial sensor-based sport activity advisory system using machine learning algorithms. Sensors (Basel, Switzerland). 2023;23(3):1137. doi: 10.3390/s23031137. DOI
5. Ramesh M, Mahesh K. Sports video classification framework using enhanced threshold based keyframe selection algorithm and customized CNN on UCF101 and Sports1-M dataset. Computational Intelligence and Neuroscience. 2022;54:3218431. doi: 10.1155/2022/3218431. DOI
6. Kakhi K, Alizadehsani R, Kabir H et al. The internet of medical things and artificial intelligence: trends, challenges, and opportunities. Biocybernetics and Biomedical Engineering. 2022;42(3):749–771. doi: 10.1016/j.bbe.2022.05.008. DOI
7. Nasiri S, Khosravani MR. Progress and challenges in fabrication of wearable sensors for health monitoring. Sensors and Actuators. A, Physical. 2020;312:112105-112105). doi:10.1016/j.sna.2020.112105. DOI
8. Haghi M, Ershadi A, Deserno TM. Recognizing human activity of daily living using a flexible wearable for 3D spine pose tracking. Sensors. 2023;23(4):15-33. doi:10.3390/s23042066. DOI
9. Gao C, Chen Y, Jiang X et al. Bi-STAN: bilinear spatial-temporal attention network for wearable human activity recognition. International Journal of Machine Learning and Cybernetics. 2023;(7):2545–2561. doi:10.1007/s13042-023-01781-1. DOI
10. Khavtur VO, Fedoniuk LYa, Sarafyniuk LA et al. Simulation of appropriate rheovasographic indicators of the femur in volleyball players of ectomorphic somatotype depending on anthropometric features. Wiad Lek. 2022;75(1):275-280. doi:10.36740/WLek202201222. DOI
11. Ankin ML, Petryk TM, Zazirnyi IM et al. Features of the femoral head fractures combined with acetabulum posterior wall fractures surgical treatment. Wiad Lek. 2022;75(12):3060-3065. doi:10.36740/WLek202212129. DOI
12. Ankin ML, Petryk TM, Radomski OA et al. Long-term results of treating patients with open fractures of low-leg bones. Wiad Lek. 2022;75(4):803-808. doi:10.36740/WLek202204110. DOI
13. Afsar MM, Saqib S, Aladfaj M et al. Body-worn sensors for recognizing physical sports activities in exergaming via deep learning model. IEEE Access: Practical Innovations, Open Solutions. 2023;11:12460–12473. doi:10.1109/access.2023.3239692. DOI
14. Baltabay M, Yazici A, Sterling M et al. Designing efficient and lightweight deep learning models for healthcare analysis. Neural Processing Letters. 2023;55:6947–6977. doi:10.1007/s11063-023-11246-9. DOI
15. Górriz JM, Ramírez J, Ortíz A et al. Artificial intelligence within the interplay between natural and artificial computation: Advances in data science, trends and applications. Neurocomputing. 2020;410:237–270. doi:10.1016/j.neucom.2020.05.078. DOI
16. Durmaz Incel O, Bursa SÖ. On-device deep learning for mobile and wearable sensing applications: A review. IEEE Sensors Journal. 2023;23(6):5501–5512. doi:10.1109/jsen.2023.3240854. DOI
17. Khater S, Hadhoud M, Fayek MB. A novel human activity recognition architecture: using residual inception ConvLSTM layer. Journal of Engineering and Applied Science. 2022;69(1):2771-2880. doi:10.1186/s44147-022-00098-0. DOI
18. Mekruksavanich S, Jitpattanakul A. Sport-related activity recognition from wearable sensors using bidirectional GRU network. Intelligent Automation & Soft Computing. 2022;34(3):1907–1925. doi:10.32604/iasc.2022.027233. DOI
19. Khatun MA, Yousuf MA, Ahmed S et al. Deep CNN-LSTM with self-attention model for human Activity Recognition using wearable sensor. IEEE Journal of Translational Engineering in Health and Medicine. 2022;10:2700316. doi:10.1109/JTEHM.2022.3177710. DOI

20. von Haaren-Mack B, Schaefer A, Pels F et al. Stress in physical education teachers: A systematic review of sources, consequences, and moderators of stress. Research Quarterly for Exercise and Sport. 2020;91(2):279–297. doi:10.1080/02701367.2019.1662878. DOI
21. Yin J, Xu J, Ren TL. Recent progress in long-term sleep monitoring technology. Biosensors. 2023:13(3):395. doi:10.3390/bios13030395. DOI
22. Pan Q, Brulin D, Campo E. Current status and future challenges of sleep monitoring systems: Systematic review. JMIR Biomedical Engineering. 2020:5(1):e20921. doi:10.2196/20921. DOI
23. Zhang C, Chen Y, Fan Z et al. Sleep-monitoring technology progress and its application in space. Aerospace Medicine and Human Performance. 2024;95(1):37–44. doi:10.3357/AMHP.6249.2023. DOI
24. Yun H, Choi SH. Technologies for sleep monitoring at home: wearables and nearables. Biomedical Engineering Letters. 2023;13(3):313–327. doi:10.1007/s13534-023-00305-8. DOI
25. Cay G, Ravichandran V, Sadhu SH et al. Recent advancement in sleep technologies: A literature review on clinical standards, sensors, apps, and AI methods. IEEE Access: Practical Innovations, Open Solutions. 2022;10:104737–104756. doi:10.1109/access.2022.3210518. DOI
26. Cojocaru AM, Bucea-Manea-Ţoniş R, Jianu A et al. The role of physical education and sports in modern society supported by IoT-A student perspective. Sustainability. 2022;14(9):5624. doi:10.3390/su14095624. DOI
27. Castelli DM, Sales Mitchell L. Chapter 7: Selective integration: Roles for public health, kinesiology, and physical education. Journal of Teaching in Physical Education: JTPE. 2021;40(3):402–411. doi:10.1123/jtpe.2020-0245. DOI
28. Cheung P. Teachers as role models for physical activity: Are preschool children more active when their teachers are active? European Physical Education Review. 2020;26(1):101–110. doi:10.1177/1356336x19835240. DOI
29. Bradette A, Cabot I. Stratégie d'évaluation permettant des choix d'activités physiques aux étudiants : impact sur leur motivation pour un cours d'éducation physique au postsecondaire. [Evaluation strategy allowing students to choose physical activities: impact on their motivation for a postsecondary physical education course]. Ejournal de la recherche sur l'intervention en éducation physique et sport -eJRIEPS. 2022;50:42–79. doi:10.4000/ejrieps.7697 (Franch) DOI
30. Vynohradov VE, Pastukhova VA, Lukyantseva HV et al. Maintaining competitive activity in elite sports with acute plantar fasciitis. Pol Merkur Lek. 2023;51(3):288-293. doi:10.36740/Merkur202303118. DOI

The work is carried out within the framework of the initiative research works of the West Ukrainian National University (Ternopil, Ukraine) « Psychodidactic technologies of educational interactions and their developmental potential» (state registration number 0119U101004) and « Psychosocial detailing of social and personal events as a technology of thinking and acting Psychosocial detailing of social and personal events as a technology of thinking and acting « (state registration number 0123U104568).

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Larysa Fedoniuk
I. Horbachevsky Ternopil National Medical University
9 Valova St., 46000 Ternopil, Ukraine
e-mail: Fedonyuk22Larisa@gmail.com

ORCID AND CONTRIBUTIONSHIP

Roman V. Gakh: 0000-0001-8668-3102 A B D
Larisa Ya. Fedoniuk: 0000-0003-4910-6888 B F
Oksana Ye. Furman: 0000-0002-7082-9717 C D
ViraO. Kramchenkova: 0000-0003-1179-8540 A E
Oleksiy I. Kuznetsov: 0000-0002-1699-7859 C 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

RECEIVED: 14.03.2025
ACCEPTED: 20.07.2025