ORIGINAL ARTICLE

CONTENTS

Manifestations of dental diseases foiiowing Covid-19: pain and oral health impacts. Using the broad population survey opportunities

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ABSTRACT

Aim: This research aimed to examine the post-COVID-19 effects on dental health among JICS survey participants, exploring oral health changes during and following the pandemic.

Materials and Methods: This study utilized random sampling through the JICS survey, involving 201 participants (aged 17–89). The control group (n=65, 32.7%) consisted of individuals without COVID-19 from 2019–2021, while the study group (n=134, 67.3%) included those who contracted the virus during this period. Symptom manifestation, intensity, and localization were assessed up to 9–12 months post-infection (2021–2022) across groups and genders, employing artificial intelligence (AI) and machine learning (ML) techniques, including descriptive analytics for pattern identification and predictive analytics for trend forecasting.

Results: Analysis of dental symptoms potentially linked to COVID-19 identified 16 conditions, including hyperesthesia, grinding teeth, gum bleeding, gum pain, and pain in upper/lower teeth. Among 201 participants (aged 18–89, mean 28.6 years), symptoms lasted an average of 9.6 – max 18 months. Of those surveyed, 134 had contracted COVID-19 at various times prior to the survey. Among them, 90 individuals (67,3% of the total number of infected respondents) reported oral pain, a 44.3% increase over the standard hyperesthesia prevalence. This group consisted of 36 men and 54 women. These 7 people (those with intense pain) constituted 7,8% Within this subgroup, 2 men and 5 women complained of intense pain, representing 2,2% and 5,6% of those with oral pain, respectively. Older age groups showed more severe symptoms, like gum pain (mean 86 years), while women reported greater severity than men.

Conclusions: The study shows dental symptoms potentially linked to COVID-19 vary by severity and age, with older individuals experiencing severe issues like gum pain. The oral health monitoring could identify symptoms and enhance treatments, especially for older adults. Further research is needed to confirm long-term impacts and refine treatments.

KEY WORDS: dental diseases, oral health, COVID-19, hyperesthesia, periodontitis, Machine Learning, Artificial intelligence (AI)

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INTRODUCTION

During a medical appointment at the Dental Medical Center of Bogomolets National Medical University in Kyiv amid the COVID-19 quarantine in 2019-2020 years [1-3], clinicians observed a clear connection between oral health issues and discomfort in patients. This observation prompted the creation of questionnaires for participants in a JICS survey. The findings revealed a link between discomfort reported by survey respondents, including those who hadn't sought medical advice. These detailed surveys were designed to uncover patterns and associations between clinical settings, diseases during epidemics, and their effects on oral health [4,5].

The study of post-COVID conditions has become a focal point in modern medicine, with dentistry emerging as an area of growing interest yet limited exploration. Current research highlights that COVID-19 extends beyond its respiratory origins, impacting various systems, including oral health. Sporadic reports have identified dental symptoms, such as tooth sensitivity, gum inflammation, and pain post-infection, but these findings lack systematic depth and validation. [3,6-9] Compared to other medical fields, where post-viral effects are more thoroughly documented, dentistry lags, with few peer-reviewed studies addressing chronic or delayed oral manifestations. This gap is striking, given the oral cavity's role as an indicator of systemic health, particularly in the context of a pandemic that has redefined health challenges [10-12].

Presently, dental research has largely concentrated on managing acute infections, leaving the long-term oral consequences of COVID-19 underexamined. Emerging evidence hints at conditions like hyperesthesia possi-

bly linked to inflammation or neurological changes, yet these remain preliminary without comprehensive analysis [7,13-16]. This study, utilizing the JICS survey and expertise from Ukrainian dentistry professionals, seeks to address this underexplored terrain. Engaging 201 participants, including those affected by COVID-19 and a comparison group, our research examines the current state of dental health post-pandemic. It is guided by questions about symptom prevalence, gender and employment differences, and the timing of oral issues, aiming to shed light on the virus's dental impact [1,9,15]. By doing so, we contribute to a clearer understanding of this evolving field, paving the way for improved clinical responses.

AIM

The aim of this study was to investigate the impact of COVID-19 on dental health, specifically to examine the prevalence, nature, and timing of oral symptoms, such as hyperesthesia, in individuals post-infection compared to a non-infected control group, using survey data and machine learning analysis to identify patterns and inform future dental care strategies. [11,15,16]

MATERIALS AND METHODS

This study was designed to evaluate the dental health effects of COVID-19, focusing on post-viral oral conditions, through a structured survey and computational analysis. The research integrated participant-reported data with advanced analytical methods to investigate these impacts systematically. This study utilized random sampling through the JICS survey, involving 201 participants (aged 18–89), 113 women, 87 men and 1 gender-neutral. The control group (n=65, 32.7%) consisted of individuals without COVID-19 from 2019–2021, while the study group (n=134, 67.3%) included those who contracted the virus during this period. Symptom manifestation, intensity, and localization were assessed up to 9–12 months post-infection (2021–2022) across groups and genders, employing artificial intelligence (AI) and machine learning (ML) techniques, including descriptive analytics for pattern identification and predictive analytics for trend forecasting.

PARTICIPANT RECRUITMENT

A total of 201 individuals were recruited using a random sampling approach to ensure diversity across age, gender, and occupational backgrounds, following established research guidelines. Participants were divided into two groups: those who had experienced COVID-19 and a control group unaffected by the virus during the study period. Eligibility required participants to be over 18 and capable of providing consent, with exclusions for those with unrelated pre-existing dental conditions or incomplete responses Fig. 1, Fig. 2.

SURVEY IMPLEMTNTATION

Data were gathered via the JICS survey, a custom questionnaire designed to collect details on dental symptoms associated with COVID-19, including their timing and characteristics, along with basic demographic information. The survey was distributed electronically through social media platforms from late 2021 to early 2022 to maximize accessibility. Each participant provided explicit consent through the JICS platform prior to completing the survey, agreeing to participate and allow data processing for the study.

DATA PROCESSING AND ANALYSIS

Initial analysis involved compiling descriptive summaries of participant responses to outline key characteristics. Subsequent in-depth analysis utilized machine learning techniques within the Python programming environment to uncover patterns and trends within the dataset. This process included comparisons with existing literature for context and statistical testing of hypotheses at a significance level of $p < 0.05$. No sensitive personal data (names, precise birth dates) was collected to ensure participant privacy.

ETHICAL FRAMEWORK

This survey raised no ethical or legal issues, as all participants voluntarily agreed to participate and permitted the use of their data for this study. Consent was obtained digitally through the JICS survey, and participants were informed of their right to withdraw at any time without consequence. All responses were anonymized and processed in compliance with the General Data Protection Regulation (GDPR), ensuring confidentiality and adherence to data protection standards. The study's reliance on self-reported data without invasive procedures further reinforced its ethical foundation.

RESOURCES

The JICS survey served as the primary data collection instrument, supported by the Python computational software for analysis. No clinical interventions or biological samples were involved, keeping the study observational in nature.

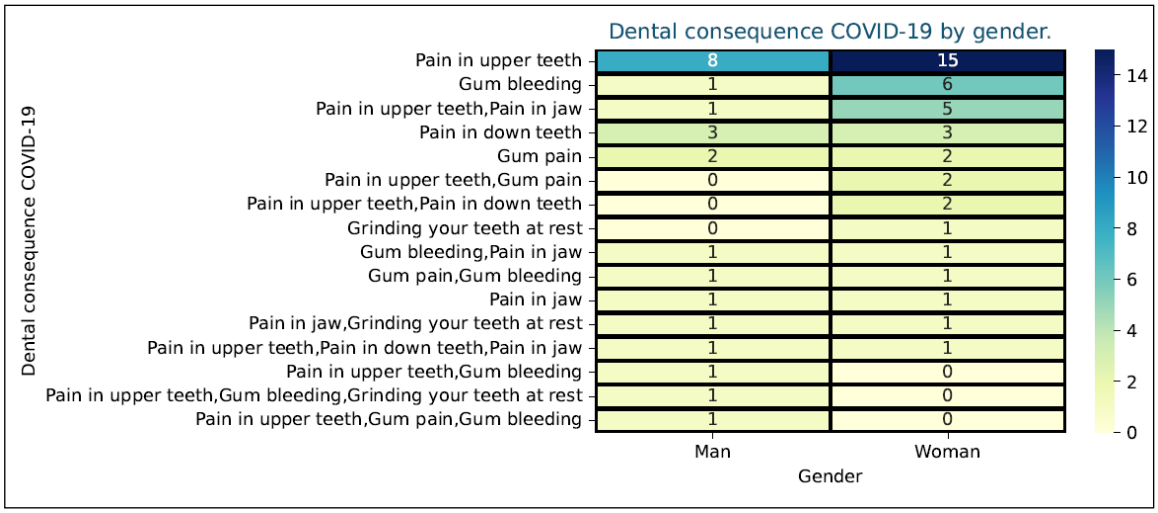

Fig. 1. Age Dental consequence COVID-19 by Gender
Picture taken by the authors

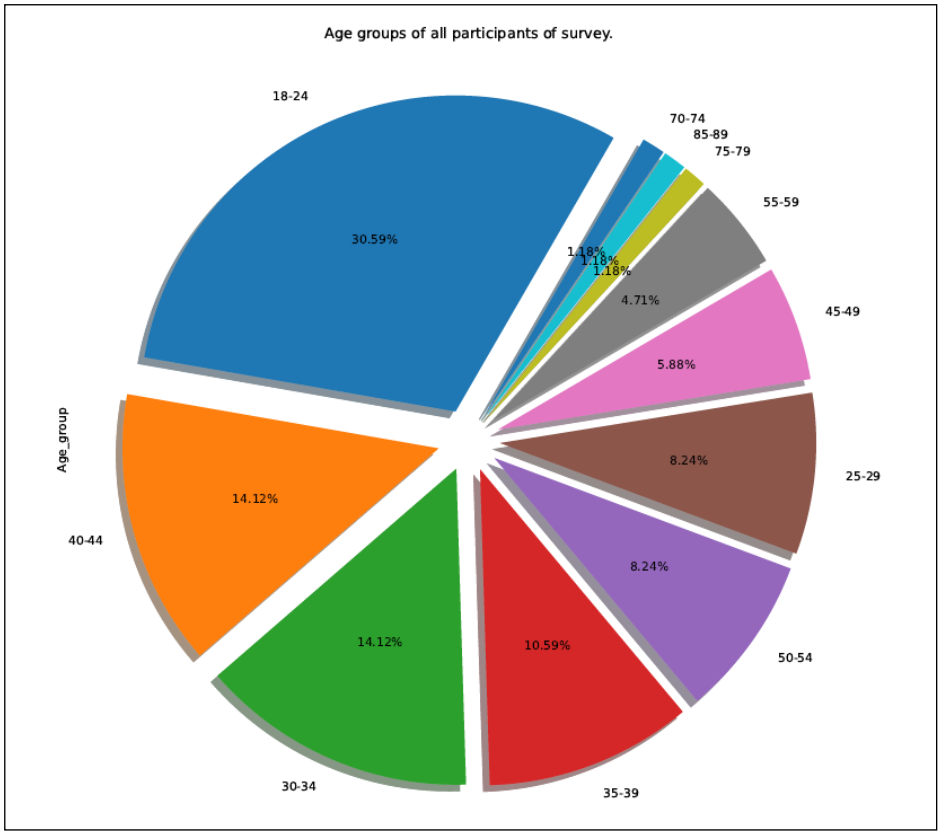

Fig. 2. The age groups of all participants in the survey
Picture taken by the authors

RESULTS

HYPOTESIS TESTING

Our study rejected the null hypothesis (H_0) that the number of dental manifestations did not increase during and after the COVID-19 pandemic based on a comparison with open-source data and prior research. Due to limited historical data, we benchmarked our survey results against reference values for dental sensitivity (hyperesthesia). These comparisons, combined with exploratory and explanatory analyses of our dataset (n=201), yielded the following key findings.

PREVALENCE AND SEVERITY OF DENTAL MANIFESTATIONS

Analysis of dental symptoms potentially linked to COVID-19 identified 16 conditions, including hyperesthesia, grinding teeth, gum bleeding, gum pain, and pain in upper/lower teeth. Among 201 participants (aged 18–89, mean 28.6 years), symptoms lasted an average of 9.6 – max 18 months. Of those surveyed, 134 had contracted COVID-19 at various times prior to the survey. Among them, 90 individuals (67,3% of the total number of infected respondents) reported oral pain. This group consisted of 36 men and 54 women. Among the surveyed population,

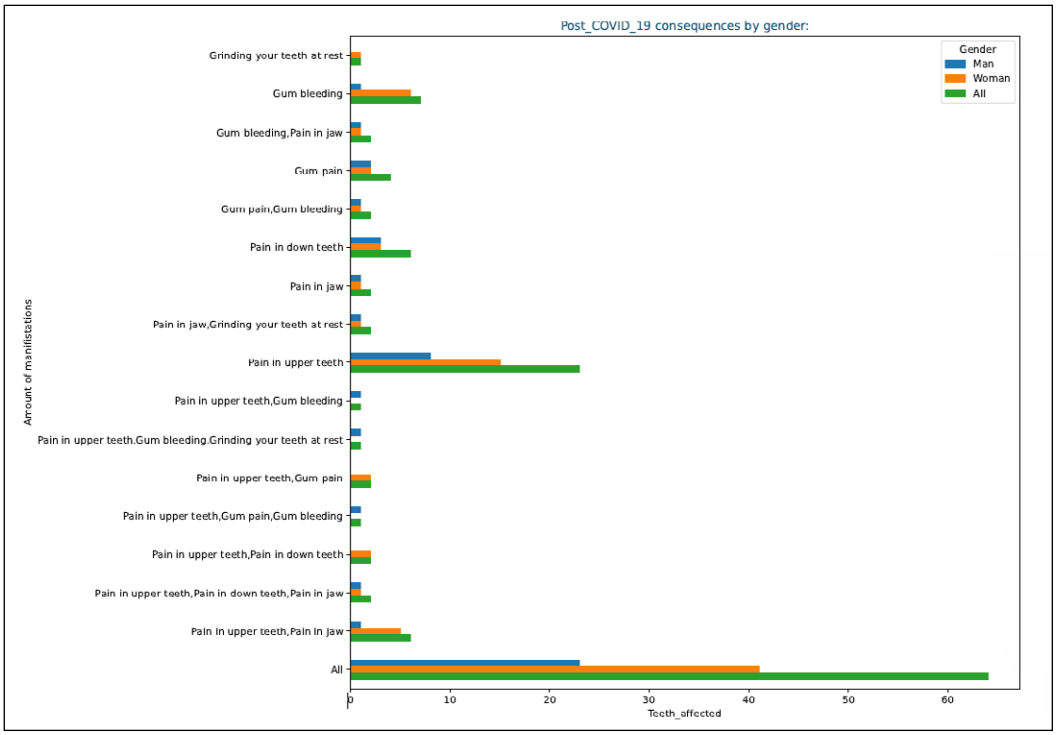

Fig. 3. Post-COVID-19 consequences by gender
Picture taken by the authors

67.3% of participants who contracted COVID-19 between 2019 and 2022 reported dental manifestations, a 44.3% increase over the standard hyperesthesia prevalence of 23% reported by Dowell and Addy [7]. Symptom severity varied: 32.5% experienced medium symptoms, 30% reported light symptoms, and 5% had severe symptoms from total number who contracted COVID-19. The most common manifestation across all participants was light pain in the upper teeth Fig.3.

The findings from this analysis, presented in Table 1, pertain to participants who had contracted COVID-19 and focus on symptom intensity. Among all surveyed participants who had COVID-19, 45.6% of those who reported experiencing pain described its intensity as moderate (n=90). Furthermore, a decrease in sensitivity was noted by 6 participants.

TEMPORAL DYNAMICS

The results of the analysis on the manifestations of post-COVID hyperesthesia and the number of teeth affected following the illness, which are correlated with the time period, are presented in Table 2. Based on the data in Table 2, the most frequently reported post-COVID oral manifestations include gum bleeding, gum pain, and pain in the upper teeth, often occurring in combination. Symptoms typically emerged within 1 to 18 months after infection, with a mean onset time ranging from 1.5 to 12 months. Patients experiencing multiple symptoms simultaneously as gum bleeding paired with jaw or tooth pain-tended to report higher numbers of affected teeth (up to 20 teeth in severe cases). Overall, these findings suggest that oral post-COVID symptoms vary widely in presentation and severity, with gum-related issues and tooth pain being the most common complaints.

The onset of dental manifestations post-COVID-19 varied significantly. Patients with medium symptoms predominantly reported issues 9 or 12 months after infection, while those with light symptoms experienced them earlier, at 1, 3, or 9 months post-infection. Severe symptoms showed no consistent temporal pattern. The number of symptoms also increased with time elapsed since infection, suggesting a prolonged impact Fig.4, Fig.5.

DEMOGRAPHIC VARIATIONS

Young patients (under 30) primarily exhibited light symptoms, middle-aged patients (30–50) reported moderate symptoms, and both middle-aged and elderly respondents (over 50) experienced unbearable symptoms. Women reported more pronounced symptoms appearing earlier post-infection compared to men, indicating a potential gender disparity. Employed individuals showed a higher incidence of dental manifestations (39.2%) compared to the control group of non-infected individuals (23%), highlighting a possible psychosomatic influence Fig.6.

LOCALIZATION AND CORRELATION

Localized symptoms, primarily affecting a single nerve, predominated over generalized manifestations in

Table 1. Distribution of the studied patients by pain intensity and gender (n/%)(n=90)

Severity of symptoms	MEN		WOMEN		Total	
	n	%	n	%	n	%
Light symptoms	14	15,6%	22	24,4%	36	40%
Medium symptoms	17	18,9%	24	26,7%	41	45,6%
Severe symptoms	2	2,3%	5	5,5%	7	7,8%
Decrease of sensitivity	3	3,3%	3	3,3%	6	6,6%
Total	36	40%	54	60%	90	100%

Source: compiled by the authors of this study

Table 2. Summary Statistics for Post-COVID Oral Symptom Groups

	Age			Time passed months			Teeth affected		
	min	mean	max	min	mean	max	min	mean	max
Consequences COVID 19									
Grinding your teeth at rest	28	28	28	18	18	18	1	1	1
Gum bleeding	21	29.6	37	3	8.4	12	0	6	20
Gum bleeding,Pain in jaw	19	19.5	20	3	3	3	3	3	3
Gum pain	19	48.5	86	1	4.75	6	3	3.75	6
Gum pain,Gum bleeding	19	21	23	3	6	9	3	3	3
Pain in down teeth	19	35	45	1	9.25	18	1	2	3
Pain in jaw	18	18	18	0	1.5	3	0	3	6
Pain in jaw,Grinding your teeth at rest	19	21	23	3	6	9	1	1	1
Pain in upper teeth	18	35.81818	72	0	6.09091	18	0	3.27273	6
Pain in upper teeth,Gum bleeding	21	21	21	6	6	6	3	3	3
Pain in upper teeth,Gum bleeding,Grinding your teeth at rest	22	22	22	12	12	12	1	1	1
Pain in upper teeth,Gum pain	23	33	43	3	6	9	3	4.5	6
Pain in upper teeth,Pain in down teeth	75	75	75	9	9	9	6	6	6
Pain in upper teeth,Pain in down teeth,Pain in jaw	19	19.5	20	1	5	9	3	3	3
Pain in upper teeth,Pain in jaw	19	34.33333	59	1	4.33333	12	1	3.33333	6

Source: compiled by the authors of this study

post-COVID-19 patients. A correlation matrix revealed a significant relationship between the number of affected teeth and symptom severity. The most striking post-pandemic manifestations included pain in the upper teeth, pain in the lower teeth, and gum pain, with post-COVID-specific symptoms such as upper teeth pain and gum bleeding standing out as notable trends.

COMPARISON TO CONTROL GROUP

The level of dental manifestations in pandemic and post-COVID-19 participants significantly exceeded that of the control group (non-infected individuals surveyed concurrently), with a 39.2% prevalence compared to the literature baseline of 23%. This further supports the rejection of H_0 and underscores the pandemic's impact on dental health.

DISCUSSION

This study successfully achieved its scientific objective of evaluating the impact of COVID-19 on dental health, specifically hyperesthesia and related manifestations, using a robust survey methodology and machine learning-assisted analysis. Our findings confirm a significant increase in dental manifestations during and after the pandemic, aligning with the growing recognition of COVID-19's systemic effects. The rejection of H_0, supported by a 44.3% higher prevalence compared to historical benchmarks , highlights the originality of our work in quantifying post-viral dental outcomes within a Ukrainian context.

The predominance of upper teeth pain and gum bleeding as post-COVID manifestations raises intriguing questions about the virus's vascular effects, such as thrombosis, which may disproportionately affect oral tissues. The temporal

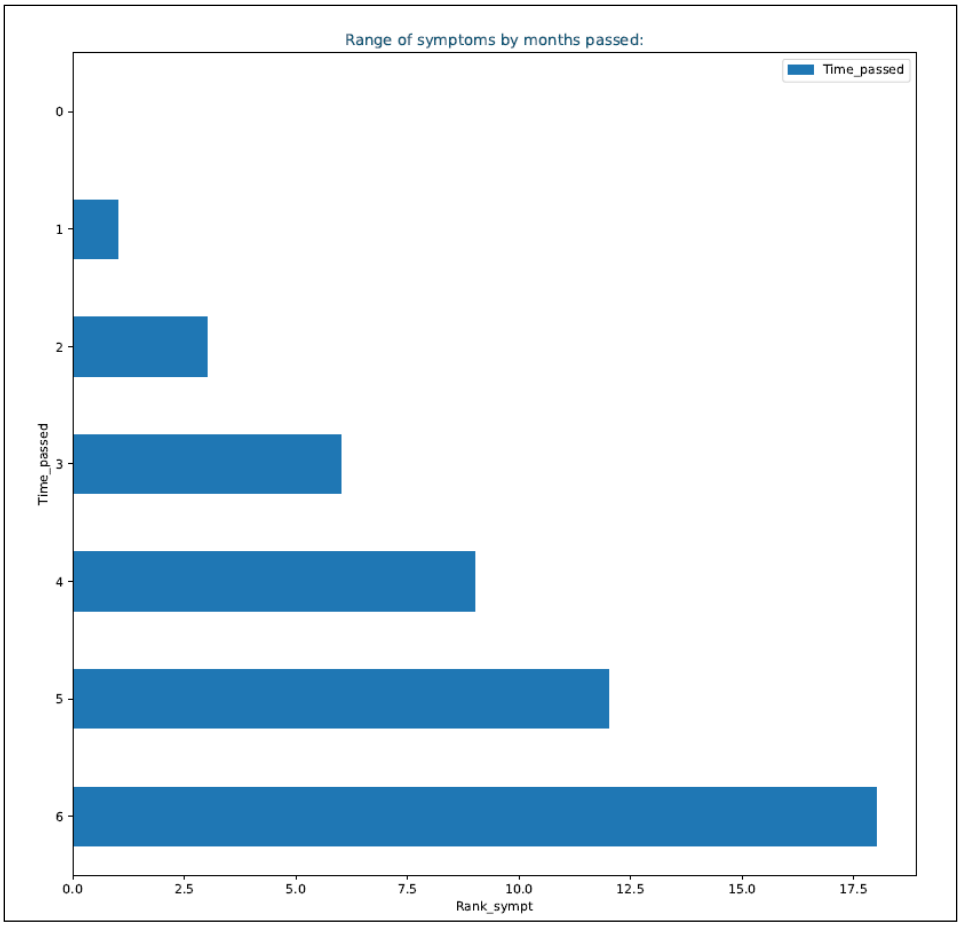

Fig. 4. Range of symptoms by months passed
Picture taken by the authors

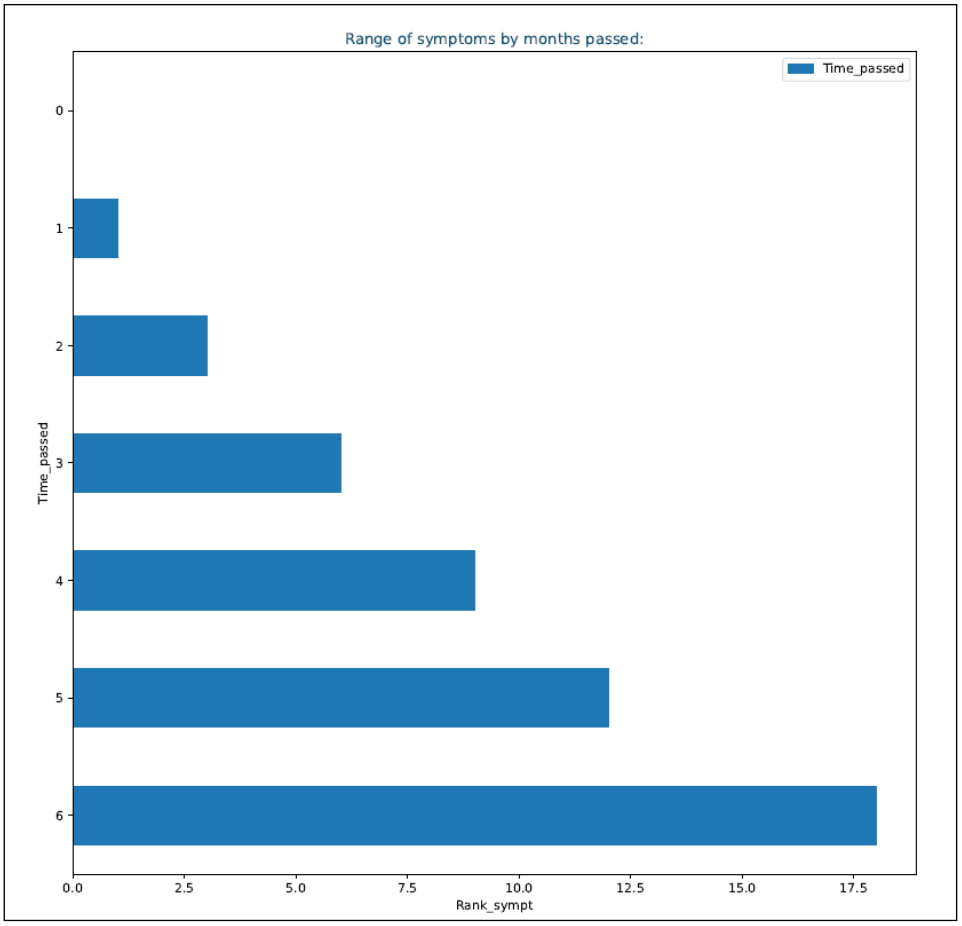

Fig. 5. Range of symptoms by months passed
Picture taken by the authors

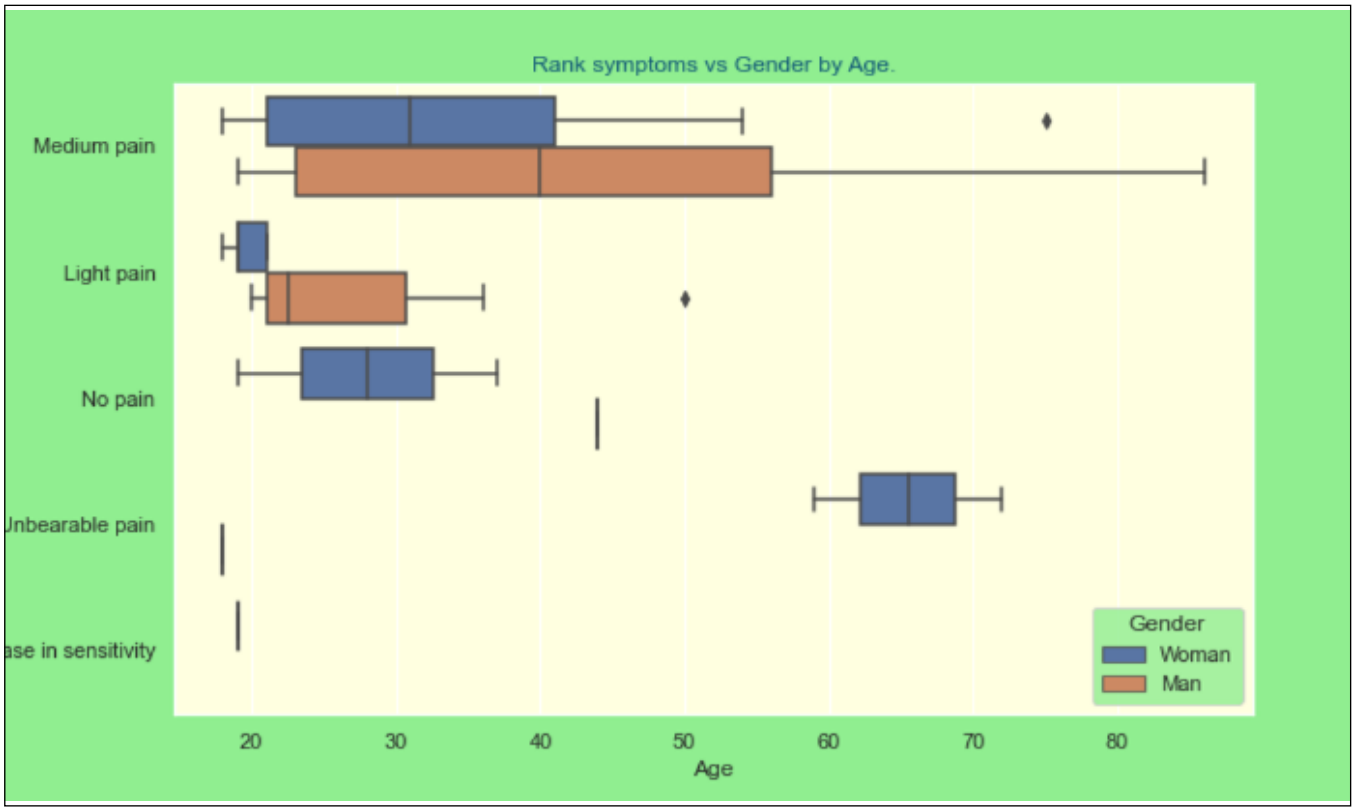

Fig. 6. Range of symptoms by months passed
Picture taken by the authors

variability-medium symptoms peaking at 9-12 months versus light symptoms at 1-3 months suggests a dynamic progression of post-viral sequelae, potentially linked to immune or neurological responses. The gender disparity, with women experiencing earlier and more severe symptoms, could reflect differences in immune response, hormonal factors, or reporting behavior, warranting further investigation. Similarly, the age-related increase in symptom severity and persistence underscores the overlap of COVID-19 effects with age-related physiological decline, a finding consistent with broader post-viral research.

The higher prevalence among employed individuals (39.2%) compared to the control group (23%) points to a psychosomatic component, possibly exacerbated by stress or reduced recovery time, as rest appears critical for mitigating symptoms. This aligns with our hypothesis that lifestyle factors modulate post-COVID dental health. The use of machine learning facilitated the identification of these patterns, demonstrating its value in medical research beyond traditional statistical methods Table 1.

However, our study has methodological limitations. The reliance on self-reported data via the JICS survey and social media distribution may introduce recall bias or selection bias despite our adherence to WHO stratification guidelines. The lack of pre-pandemic baseline data from our population limits direct historical comparisons, forcing reliance on external references [7,16,15]. Additionally, the sample size (n=201), while diverse, may not fully represent the broader population, particularly regarding genomic or regional differences in viral response.

The findings offer practical implications for dental practice, enabling clinicians to prioritize high-risk groups (women and older adults) and tailor diagnostics to post-COVID manifestations like upper teeth pain and gum bleeding. The study lays a foundation for future research, potentially in collaboration with Bogomolets National Medical University and the Ukrainian government. Expanding the scope to include pre-pandemic symptoms, non-random sampling from dental clinics, and genomic analysis could further elucidate the virus's heterogeneous effects.

CONCLUSIONS

The research bridges a critical gap in post-COVID dental health, offering novel evidence of its prevalence, severity, and demographic patterns through a comprehensive survey and analysis. By integrating these findings with ongoing global studies, we aim to enhance patient outcomes and inform dental care in the post-pandemic era, addressing the unique challenges posed by post-viral effects on oral health. A pivotal element of this work is the application of artificial intelligence – Machine

Learning, which has significantly enhanced our ability to uncover complex trends and holds transformative potential for dentistry. Currently, AI, through machine learning, is being utilized to process large medical datasets, enabling the identification of subtle correlations, such as those between symptom severity and affected teeth in our study, while also powering clinical tools like automated imaging diagnostics and predictive risk models. Looking ahead, AI's future in dentistry promises advancements such as personalized treatment plans based on predictive analytics, integration of genomic data to explain variable symptom expression, and scalable research frameworks to tackle evolving viral threats. This synergy will ultimately improve patient well-being in a rapidly changing health landscape.

The relevance of studying the consequences of COVID-19 cannot be overstated. Geopolitical instability, mass daily migrations, and living in emergency conditions amplify the risks of new epidemics emerging. In this context, researching the impact of COVID-19 and related viruses on pain manifestations in patients remains highly significant and in demand.

Dentistry holds a special place in healthcare system, as dentists are among the most frequently visited specialists and often act as observers of family health, similar to family doctors. Given the significant strain on the oral cavity and its critical role as the initial segment of the gastrointestinal tract, the study of this topic takes on exceptional importance.

The results of our work, leveraging Machine Learning (a core component of Artificial Intelligence – AI), could contribute to improving treatment approaches, adapting medical strategies to new and evolving diseases, and enhancing patients' quality of life.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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