



## Covid-19 Vaccination and Dentistry: Are we Facing New Challenges or Working within our Possibilities? Analytical Review

Myroslav Goncharuk-Khomyn<sup>1,a\*</sup>, Renata Pohorilyak<sup>1,b</sup>, Mariia Stetsyk<sup>2,c</sup>, Alessandro Cavalcanti<sup>3,d</sup>, Yasemin Yavuz<sup>4,e</sup>, Maryana Pasichnyk<sup>5,f</sup>

<sup>1</sup>Department of Public Health and Humanitarian Disciplines, Uzhhorod National University, Uzhhorod, Ukraine

<sup>2</sup>Department of Prosthetic Dentistry, Faculty of Dentistry, Uzhhorod National University, Uzhhorod, Ukraine

<sup>3</sup>Department of Dentistry, School of Dentistry, State University of Campina Grande-Paraíba, Campina Grande, Brazil

<sup>4</sup>Department of Restorative Dentistry, Faculty of Dentistry, Harran University, Şanlıurfa, Türkiye

<sup>5</sup>Therapeutic Dentistry, Faculty of Dentistry, Danylo Halytsky Lviv National Medical University, Lviv, Ukraine

\*Corresponding author

### Reviews

#### History

Received: 30/03/2021  
Accepted: 08/03/2022

#### License



This work is licensed under  
Creative Commons Attribution 4.0  
International License

### ABSTRACT

**Objective:** To systematize available data regarding COVID-19 vaccination aspects among dental specialists and highlight relevant occupationally-related features of vaccination challenges.

**Materials and Methods:** Search of pertinent literature sources associated with above-formulated objective was provided via PubMed Central database (<https://www.ncbi.nlm.nih.gov/>) and Google Scholar search engine (<https://scholar.google.com/>). Criteria of publication date included 2020-2022 years period. Publications in English or at least with English abstract/summary were collected within primary sample for further preliminary content-analysis. All articles collected for in-depth content-analysis were evaluated due to the text-mining, text-identification and text-extraction principles with further clusterization and systematization of outcomes at the Microsoft Excel 2019 software (Microsoft Office, Microsoft, 2019).

**Results:** After full reading of articles' texts 28 of them were categorized as those containing new and/or unique information, interpretations or facts, out of which 12 were cross-sectional online surveys, 4 were editorials, 7 were literature/systematic/clinical reviews, 1 was brief report, 1 was opinion article, 1 was ethical moment, 1 was advice article, and 1 was web-source. New challenges related with COVID-19 vaccination within dental field are represented by personal hesitancy of dental professionals and students, which in turn associated with such factors as provided information support, previous COVID-19 experience, fear of getting infected or transmit disease to the patients or family members, fear of potential post-vaccination side-effects development, changes of occupational status, and interaction within dental team.

**Conclusions:** Further improvements of dental care field possible only after vaccination of dental professionals. Vaccination of dentists is widening window of their possibilities regarding inclusion as members of COVID-19 vaccine's delivery team and participation within "behaviorally informed strategies" and public motivational programs, which in turn is aimed at amplification of positive willingness for COVID-19 vaccination among general public.

**Keywords:** COVID-19, Vaccination, Dentistry

<sup>a</sup> [myroslav.goncharuk-khomyn@uzhnu.edu.ua](mailto:myroslav.goncharuk-khomyn@uzhnu.edu.ua)

<sup>b</sup> <https://orcid.org/0000-0002-7482-3881>

<sup>c</sup> [mariia.stetsyk@uzhnu.edu.ua](mailto:mariia.stetsyk@uzhnu.edu.ua)

<sup>d</sup> <https://orcid.org/0000-0002-4586-5177>

<sup>e</sup> [godovanetspediatricdepartment@gmail.com](mailto:godovanetspediatricdepartment@gmail.com)

<sup>f</sup> <https://orcid.org/0000-0001-5961-4996>

<sup>b</sup> [renata.pohoriliak@gmail.com](mailto:renata.pohoriliak@gmail.com)

<sup>d</sup> <https://orcid.org/0000-0002-7388-9969>

<sup>d</sup> [alessandrouepb@gmail.com](mailto:alessandrouepb@gmail.com)

<sup>e</sup> <https://orcid.org/0000-0003-3572-3332>

<sup>f</sup> [prostheticdentistrydepartment@gmail.com](mailto:prostheticdentistrydepartment@gmail.com)

<sup>f</sup> <https://orcid.org/0000-0003-3437-7554>

**How to Cite:** Goncharuk-Khomyn M, Pohorilyak R, Stetsyk M, Cavalcanti A, Yavuz Y, Pasichnyk M(2022). Covid-19 Vaccination and Dentistry: Are we Facing New Challenges or Working within our Possibilities? Analytical Review, Cumhuriyet Dental Journal, 25(2): 179-186.

### Introduction

Due to the international COVID-19 vaccination dataset by the 13<sup>th</sup> of May 2021 near 4.4% of population worldwide have been fully vaccinated against COVID-19, which equals to near 346 million people.<sup>1</sup> Nevertheless, while some countries demonstrating progressive increase tendency of vaccination rate (62.75% in Israel, 53.20% in UK, 48.39% in Bahrain, 46.23% in USA, 46.94% in Chile, 46.41% in Hungary, 35.70% in Germany and 28.56% in France on the 13<sup>th</sup> of May 2021), other countries, like Ukraine, which is native for corresponding author, characterized with only 13,661 persons fully vaccinated, and near 2.1% of population received 1 dose of vaccine.<sup>1</sup> Such great differences among above analyzed vaccination

levels argued by the influence of various economical, national, social and technical-related factors and reasons, which are remaining under ongoing public health research as urgent and relevant investigation topics.<sup>2</sup>

Despite relative availability of different vaccines including Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Johnson&Johnson, Moderna, Sinovac, impact of personal and occupationally associated factors also should not be excluded during analysis of vaccination coverage rates.<sup>3</sup> Moreover, vaccination issues among healthcare providers of different specialties seeking for more in-depth analysis considering direct contact of medical personnel with significant number of patients.

Even though telemedicine has widened possibilities for qualified medical care during COVID-associated quarantine period with elimination of direct physical contact<sup>4</sup>, but only vaccination supported a new phase arising within classical pandemic pattern which could be interpreted as transitional to quazi-normal.

Dentistry as a peculiar branch of medicine has undergone its fundamental changes under pandemic restrictions, while some of them have been similar to those within all medical fields, while others were characterized with specific occupationally-related pattern.<sup>4,5,6,7</sup> Number of publications have presented dental specific measures regarding prevention of COVID-19 spread, while the most relevant studies reported about COVID-19 oral symptoms which could be used for early and comprehensive diagnostics of patients affected by coronavirus disease.<sup>4,5,7</sup> Such manifestation include tongue's color changes, tongue's plaque changes, salivary glands' functional and structural alterations, loss of taste and possible dysesthesia, which demonstrated various connections with mild, moderate and severe form of COVID-19 infection.<sup>4,7</sup>

Another COVID-19 related aspect, which is of high clinical importance in dental practice, includes vaccination of dental specialists and their role in the promotion of COVID-19 vaccination programs among dental patients. In 2021 vaccination progression among dental specialists demonstrated some issues regarding hesitancy aspects, which impact the readiness of dental field in general to transfer into new on-going vaccination era of COVID-19 pandemic.

## Objective

To systematize available data regarding COVID-19 vaccination aspects among dental specialists and highlight relevant occupationally-related features of vaccination challenges.

### Protocol of provided analytical review

Protocol of present study, its' design and realization phase were reviewed and approved by Ethical Committee of Medical Faculty #2 at Uzhhorod National University (Ukraine) (#26020221) on 26/02/2021 due to the principles with Helsinki Declaration of 1975, as revised in 2008.

Search of pertinent literature sources associated with above-formulated objective was provided via PubMed Central database (<https://www.ncbi.nlm.nih.gov/>) and Google Scholar search engine (<https://scholar.google.com/>). Search algorithm using Mesh-terms in PubMed was provided in the following form: ("covid-19 vaccines"[MeSH Terms] OR ("covid-19"[All Fields] AND "vaccines"[All Fields]) OR "covid-19 vaccines"[All Fields] OR "covid 19 vaccine"[All Fields]) AND ("dentistry"[MeSH Terms] OR "dentistry"[All Fields]).<sup>8,9</sup> Search within Google Scholar was held by the following keywords: "dentistry", "COVID-19",

"vaccination".<sup>10</sup> Criteria of publication date included 2020-2022 years period. Publications in English or at least with English abstract/summary were collected within primary sample for further preliminary content-analysis.

Aim of preliminary content-analysis was oriented on the systematization of final publications study sample strictly associated with formulated objective of present research. Preliminary consistent content-analysis included following phases: 1) evaluation of publication title; 2) assessment of provided abstract/summary; 3) separation of keystone research aspects and exploring their relation to the COVID-19 vaccination issues within dentistry based on abstract/summary analysis. Preliminary content-analysis was held due to the basic principles of intellectual filtering and text mining, while absence of any relation to the topic of COVID-19 vaccination within dentistry was dominant reason for article exclusion from the further research.

Final (in-depth) content-analysis was provided among articles that positively undergone procedure of preliminary content-analysis due to the standard protocol, categories of which included: aspects of COVID-19 vaccination problems among dentists, personal hesitancy/willingness of dental specialists to undergo COVID-19 vaccination, potential outcomes of undergoing COVID-19 vaccination or refusal to such.

All articles collected for in-depth content-analysis were evaluated due to the text-mining, text-identification and text-extraction principles with further clusterization and systematization of outcomes at the Microsoft Excel 2019 software (Microsoft Office, Microsoft, 2019). Phased process of in-depth content analysis included following steps:

1. Formulation of content-analysis categories ("Bibliographical record of the analyzed article", "Origin of an article: Journal, Database", "Type of the Research", "Key points and main findings", "Unique information provided within the article considering COVID-19 vaccination and dentistry", "Repetitive/previously provided information duplicated within article considering COVID-19 vaccination and dentistry");
2. Categorization of unique and repetitively provided information considering COVID-19 vaccination and dentistry due to its relationship with specific article or articles;
3. Diagramming of connections between different articles considering uniqueness or repetitive nature of relevant information and clustering of such with further comparison;
4. Grouping of outreached findings and their Interpretation with formulation of contextual conclusions.<sup>11,12,13,14</sup>

For the evidence-expansion purpose Connected Papers service (<https://www.connectedpapers.com/>) was additionally used,<sup>15</sup> which helped to analyze related, prior and derivatives researches for all targeted publications, included for the in-depth content analysis (Figure 1).

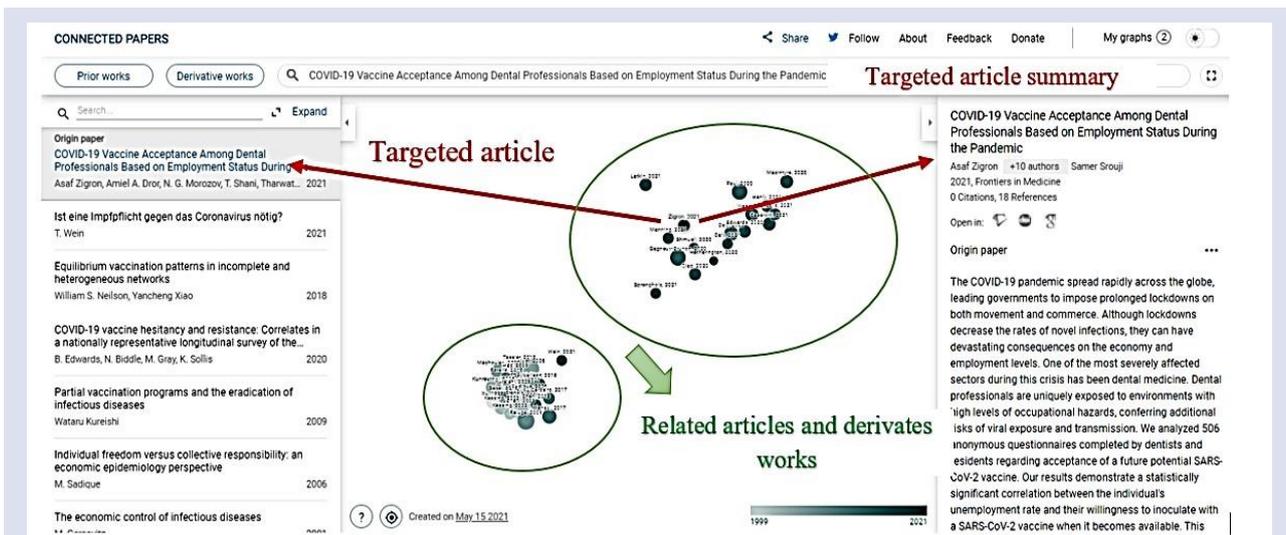


Figure 1. Interface of Connected Papers Service used for accompanied literature sources.

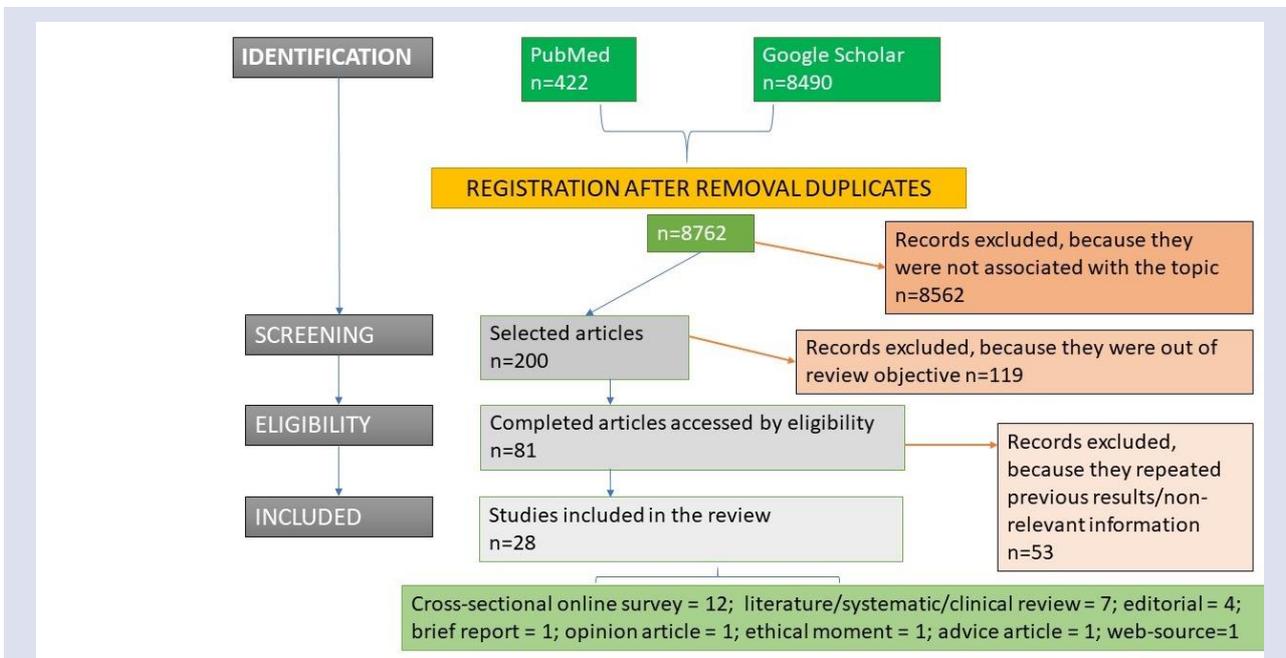


Figure 2. Flowchart of provided literature search

**Studies collected for in-depth analysis**

8912 results of the search were found and distributed as follows: 422 in PubMed and 8,490 results in Google Scholar.

After removing duplicates and articles not associated with the objective of the study, only 200 publications remained. In-detail analyses of titles and summaries/abstracts helped to optimize study sample of article to 81, all of which were analyzed in full manner during in-depth content-analysis. After full reading of articles’ texts 28 of them were interpreted as those containing new and/or unique information, interpretations or facts. Other 53 completed articles accessed by eligibility were excluded because of duplicating results or demonstrating data analogically or similarly represented in other articles, or not representing results relevant to up-to-

date actual continuity regarding COVID-19 vaccination issues within dentistry field. At the end, 28 articles were included in this review, out of which 12 were presented by cross-sectional online surveys, 4 – by editorials, 7 – by literature/systematic/clinical reviews, 1 – by brief report, 1 – by opinion article, 1– by ethical moment, 1 – by advice article, 1 – by web-source (Figure 2)

**General aspects of COVID-19 and dentistry**

COVID-19 impact on dental field could be nominally categorized on such before vaccination phase and such of on-going vaccination phase.<sup>16</sup> While data on before vaccination phase is processing through progressive detalization, analysis and systematization, data on on-going vaccination phase is still collecting and could be structured only sometime after.

Coronavirus disease changed not only dental care system itself with stratification of dental appointments based on emergency need, while post-poning non-urgent dental visits and implementing hygienic restrictions during dental treatment (at the level of different national accepted protocols and expert recommendations), but also directly impacted oral health of infected persons regarding pathological changes of tongue, mucous, salivary gland and different kind of dysfunctions.<sup>17,18,19</sup> Also COVID-19 made a tremendous impact on dental practice and education associated with personal and financial losses and limitations,<sup>20</sup> and changed tendencies of ongoing laboratorial and clinical dental studies.<sup>21</sup>

COVID-19 vaccination has not only personal pathogen-targeted protection effect, which could spread to the level of public immunization, but it also demonstrates socio-economic impact, while helping to re-establish usual public interaction and communication, educational and academical activities, community's national and international ecosystems. Nevertheless, vaccination is not the only one available instrument in translation to quazi-normal post-vaccination pandemic period, but other social marketing and promotion strategies should also take place.<sup>22</sup> Previously researchers highlighted the importance of so-called "behaviorally informed strategies" for effective COVID-19 vaccination and slowdown of further pandemic spread.<sup>23</sup>

#### **Hesitancy of dental specialists regarding COVID-19 vaccination**

Study provided within Israel, which characterized with the highest vaccination rate so far, found that dental hygienists demonstrated greater level of hesitancy regarding COVID-19 vaccine compare to dentists and general population, while all analyzed samples demonstrated more negative attitudes regarding COVID-19 vaccine compare to other forms of vaccine.<sup>24</sup> Turkish dentists demonstrated 84.1% positive respondents' willingness to receive COVID-19 vaccine. Dentists who were agreed on vaccination also were characterized with statistically higher means of "Fear of COVID-19" scores compare to those who didn't want to get vaccinated.<sup>25</sup> Among Greek health care providers dental specialists demonstrated the highest rate of COVID-19 vaccination acceptance (near 83%) compare to physicians and pharmacists.<sup>3</sup> Also outcomes obtained in above mentioned studies demonstrated that provision of official information regarding safety and low risks of possible side-effect development after COVID-19 vaccination helped to decrease level of hesitancy among medical care employees.<sup>24,25</sup>

Cross-sectional study demonstrated that healthcare workers had higher willingness to get vaccinated in comparisons with control group (82.95% against 54.31%), while fear of passing coronavirus infection, fear of getting infected and previous infection in anamnesis were the main factors of motivation for immunization.<sup>26</sup> Despite that average of 22.51% (ranging within 4.3-72%)

healthcare workers demonstrated hesitancy regarding COVID-19 vaccination.<sup>27</sup> Fear of post-vaccination side-effects was the main factor of reduced personal motivation for COVID-19 vaccination.<sup>26</sup> Nevertheless, it should be kept in mind that factor of fear regarding development of post-vaccination side-effects is modifiable by the adequate informational assistance and provision of supportive results obtained after targeted studies.

Observational research dedicated to the COVID-19 vaccination experience among United States-based dental professionals and students demonstrated that over 80% of all respondents felt moderately to very safe while practicing after the COVID-19 vaccine was made available. Also, more than 75% of dental students and specialists had shown moderate or high levels of confidence regarding protection they have received after vaccination within the pandemic conditions.<sup>28</sup>

Study provided among United States hygienists reported the highest level of vaccine hesitancy among specialists aged 26-39 years and those who had been infected with COVID-19 during the time of the survey. Factor of being contracted by the COVID-19 was statistically associated with higher adjusted odds ratio of hesitancy regarding COVID-19 vaccination.<sup>29</sup> The need for COVID-19 vaccination promotion among dental hygienists was specifically highlighted in previous study as such specialists categorized as those who could effectively promotes COVID-19 vaccination programs among general population.<sup>29</sup>

#### **Hesitancy of dental and medical students regarding COVID-19 vaccination**

Survey provided among medical and dental students found that dental students were characterized with near two-time higher prevalence of hesitancy to receive COVID-19 vaccine, even though greater portion of dental students-respondents reported of having COVID-19 or know somebody who was infected.<sup>30</sup> Medical students represented higher belief in the need of mandatory vaccination both among public and health care providers and greater willingness to participate in COVID-19 vaccine trials compare to dental students.<sup>30</sup> Such outcomes demonstrated occupationally specific trend regarding vaccination hesitancy, which should be taken into account while developing different targeted motivational strategies for reaching wider COVID-19 immunization effect.

In other study only 55.8% dental students were agreed on COVID-19 vaccination right after FDA vaccine approval, while only 32.9% demonstrated the will to take part in COVID-19 vaccine trials.<sup>31</sup> Out of number of dental students who were not motivated to take vaccine, 63% would be agreed on vaccination if such was mandated by health care system, while 16.3% would refuse to vaccinate even under mandatory regime.<sup>31</sup> Interpretation of such outcomes must be provided considering the fact that nearly 95% respondents agreed that they have a pronounced risk of getting infected with coronavirus disease.

In both studies dental and medical students agreed with the level of more than 90% that they need to learn about

vaccine as future healthcare providers for themselves safety and for the safety of their patients, but in COVID-19 vaccine hesitant group only 36.7% of respondents would recommend vaccine for their patients and only 34.0% would give vaccine for their patients, which was statistically lower compare to the analogical results reported in COVID-19 vaccine acceptance group.<sup>30,31</sup>

A health care student-based online survey reported also that concerns about possible side effects and use of personal protective behavior as an alternative to the COVID-19 vaccination could be categorized as factors associated with higher level of hesitancy regarding COVID-19 vaccination.<sup>32</sup> Systematic review dedicated to the global COVID-19 acceptance evaluation demonstrated that mains reasons behind vaccine hesitancy mostly based on insufficient levels of education, deficiency of awareness, and inefficient government efforts and initiatives.<sup>33</sup>

Considering above-mentioned information implementation of additional educational strategies aimed to improve knowledge of students regarding COVID-19 vaccines are of high relevance, since such approach would support increase of positive attitudes towards COVID-19 public immunizations not only among health care providers, but also among patients.

#### **Oral side effects of COVID-19 vaccination**

Cirillo reported about such orofacial COVID-19 vaccine-associated side effects as peripheral facial paralysis, swelling of face, lips or tongue related with anaphylaxis reaction.<sup>34</sup> Description of such adverse effects were characterized with high level of heterogeneity, and frequency of their occurrence was generally rare.<sup>34</sup> Vaccine side effects registered among health care workers in Czech Republic included blisters and ulcers occurrence in 36% and 14% cases respectively, development of halitosis in 14% cases, bleeding gingiva in 11.4% cases and accumulation of plaque in 10.5% cases.<sup>35</sup> Most of oral reactions developed either in 1-3 days or within 1 week after vaccination, while lesions were predominantly localized on the lips, and with relatively analogical frequency at the buccal mucosa, tongue, palate and gingiva. Occurrence of side effects located within oral cavity was statistically associated with development of general side effects and duration of such.<sup>35</sup>

But if broadly speaking no significant oral side effects of COVID-19 vaccination have been reported so far, which evidently could be related with vaccination process. It is recommended to use Hill's criteria of causal inference and provide in-depth analysis of patients' anamnesis data to make some definitive conclusion about potential significance of side effects after vaccination and its connection with vaccine injection.<sup>35,36,37</sup>

#### **Occupational status changes and COVID-19 vaccination**

In questionnaire-based study it was found that changes within occupations status (from being employed to getting unemployed) statistically correlates with higher acceptance of COVID-19 vaccine among dentists: the

highest acceptance level of 94-95% for COVID-19 vaccination was registered among orthodontists, general dental practitioners and endodontists, among which only 5%, 14% and 7% respectively were providing dental care during quarantine period; while among maxillofacial surgeons, 87% of which were still working during lockdown, only half of respondents positively reacted to the willingness of vaccination.<sup>38</sup>

#### **Occupational status changes and COVID-19 vaccination**

In questionnaire-based study it was found that changes within occupations status (from being employed to getting unemployed) statistically correlates with higher acceptance of COVID-19 vaccine among dentists: the highest acceptance level of 94-95% for COVID-19 vaccination was registered among orthodontists, general dental practitioners and endodontists, among which only 5%, 14% and 7% respectively were providing dental care during quarantine period; while among maxillofacial surgeons, 87% of which were still working during lockdown, only half of respondents positively reacted to the willingness of vaccination.<sup>38</sup>

#### **Dentists and COVID-19 vaccine delivery: window of opportunities**

Due to present window of opportunities dentists should be evaluated as additional personal for delivering COVID-19 vaccines with possibility to implement such approach within different immunization models.<sup>37,40</sup> There are several positive interlinks between oral mucosa immunity and perspectives of COVID-19 vaccine developments, which associated with specific humoral and cell responses, simpler route of administration and minimized risk of needle usage. Nevertheless, immune exclusion pattern should be taken into account, since direct delivery of vaccine through oral mucous may support tolerance rather than corresponding immunization effect.<sup>41</sup> Fair enough that adaptation of vaccination delivery strategies should preliminary get corresponding approvals from different regulatory institutions and agencies and should be organized within complex clinical databases and nets for unification of income and outcome parameters.

#### **Dentists and vaccination priority**

Ethical argumentation for vaccination of dentists as primary health care providers and doctors with high risk of exposure to COVID-19 by the first level priority principle based on the several facts: 1) dental health is a component of quality of life, that is why proper dental treatment enhances high level of general quality of life; 2) dentists have ethical responsibilities to provide specific interventions within pandemic conditions and respond to the challenges caused by the spread of coronavirus disease; 3) dentists could motivate their patients to get vaccinated which will support general immunization strategies.<sup>42</sup> Moreover, vaccination of dentists would support proper provision of dental care, and latter is

associated with improvement of oral microbiome among dental patients with enhancing of its resistance to the viral and pathogenic bacterial influence.<sup>43</sup>

Federal USA guidance on vaccination priority stratification does not include any difference in order among healthcare workers in hospitals, those who directly contact with COVID-19 patients and doctor of other specialties, including dentists.<sup>44</sup> While in six states physicians of other specialties different from those working within hospitals or directly with COVID-19 patients were categorized with lower priority to vaccination.<sup>44</sup>

In cases where dental employee is not agreed to get COVID-19 vaccinated, then by the Dawson dental team, employer and employee must find similar point of interaction regarding that dentist should have argued reason to refuse vaccination; moreover infection controlling measures must be fully implemented within a practice and all responsibilities regarding infection transmission must be precisely validated and distributed due to the relevant legislation bases.<sup>45</sup>

#### **Future of dentistry and COVID-19**

Primary developed protocols for dental care provision during COVID-19 pandemic before vaccine era may now look too strict and rigid, nevertheless it's too early to conclude that they are overly limiting during vaccination period. Most likely that such protocols should be modified and adapted due to present reality while considering all the infection-restricting requirements.<sup>46</sup> Control of dental clinic environment, maintenance of strict hygienic restrictions and infection control precautions, temperature screening, pre-treatment questionnaires regarding COVID-19 experience, routine use of face masks and respirators possibly may stay as obligatory adaptational measures until full resolution of pandemic, and even after it.<sup>47</sup> Prognostically vaccination against COVID-19 would support return to the greater prevalence of conservative procedures in dental practice and relative decrease of emergency surgeries and associated interventions. Future model of dental education in turn seems to get modified into hybrid one rather than in strictly distant online mode.<sup>48</sup>

#### **Oral COVID-19 vaccines and antiviral drug for treatment of COVID-19**

Recent studies demonstrated possible strategies of using so-called oral vaccines or specific anti-viral treatment against COVID-19, which could be delivered orally. Among different vaccination strategies emerging nowadays RPS-CTP vector system was described as perspective for the development of oral mucosal COVID-19 vaccine and as a promising vaccine platform for resolving clinical challenges regarding optimal vaccine delivery.<sup>49</sup> *Saccharomyces cerevisiae* surface display system, *Salmonella* strains and *Bacillus subtilis* spores were described as perspective platforms for the development of effective oral COVID-19 vaccines, even though results of implementing such were obtained only

in experimental conditions within the animal-based models.<sup>50,51,52</sup> At the end of 2021 FDA authorized first oral antiviral drug for treatment of COVID-19, which could be prescribed for adults and children with mild-to-moderate forms of coronavirus disease. Recent meta-analysis reported that three novel oral antiviral drugs for COVID-19 associated with reduced levels of mortality and hospitalization rates, while demonstrating high safety levels.<sup>53</sup>

#### **Conclusions**

Experience received during pre-vaccination period of COVID-19 pandemic should be considered through the re-establishment of usual dental practice modes and adaptation to the new realities of dental care while vaccination is in progress. COVID-19 vaccine should not be interpreted as only possible universal mechanism for restitution of "as it used to be" dental practice because of differences of vaccination rates worldwide, new mutations of virus, and hesitancy of dental specialists and dental students regarding vaccination. Social distancing, infection controlling measures, routine use of masks and respirators with rigid adherence to hygienic restrictions and disinfection arrangements over dental clinical environment remain relevant and essential for on-going vaccination phase of COVID-19 pandemic.

New challenges related with COVID-19 vaccination within dental field are represented by personal hesitancy of dental professionals and students, which in turn associated with such factors as provided informational support, previous COVID-19 experience, fear of getting infected or transmit disease to the patients or family members, fear of potential post-vaccination side-effects development, changes of occupational status, and interaction within dental team.

Vaccination of dentists is widening window of their possibilities regarding inclusion as members of COVID-19 vaccine's delivery team and participation within "behaviorally informed strategies" and public motivational programs, which in turn is aimed at amplification of positive willingness for COVID-19 vaccination among general public.

#### **Acknowledgements**

Presented study was not supported by a grant or any other kind of funding.

#### **Conflicts of Interest Statement**

Authors declare no conflicts of interest

#### **Ethical approval**

This study represented in the form of review article with no experience provided. But Helsinki declaration was considered for all steps of manuscript preparation. The authors claim that no part of this paper is copied from other sources, and all the fragments of the text

interpreted from other publications supported with corresponding citations and references.

### Authors' contributions

MGK, AC and YY contributed in searching, reviewing the literature, summarizing the results, and writing up the manuscript. RP and MS also contributed to reviewing the literature and summarizing the results. MGK, AC and MP contributed to the design and finalize the manuscript.

### References

1. Our World in Data: Statistics and Research. Coronavirus (COVID-19) and Vaccinations. <https://ourworldindata.org/covid-vaccinations>. Accessed 15 May 2021.
2. Nguyen KH, Srivastav A, Razzaghi H, Williams W, Lindley MC, Jorgensen C, Abad N, Singleton JA. COVID-19 vaccination intent, perceptions, and reasons for not vaccinating among groups prioritized for early vaccination—United States, September and December 2020. *Am J Transplant* 2021;21(4):1650-1656.
3. Papagiannis D, Rachiotis G, Malli F, Papathanasiou IV, Kotsiou O, Fradelos EC, Giannakopoulos K, Gourgoulis KI. Acceptability of COVID-19 vaccination among Greek health professionals. *Vaccines* 2021;9(3):200.
4. Horzov L, Goncharuk-Khomyn M, Kostenko Y, Melnyk V. Dental Patient Management in the Context of the COVID-19 Pandemic: Current Literature Mini-Review. *The Open Public Health J* 2020;13(1):459-463.
5. Spagnuolo G, De Vito D, Rengo S, Tatullo M. COVID-19 outbreak: an overview on dentistry. *Int J Environ Res Public Health* 2020;17(6):2094.
6. Coulthard P. Dentistry and coronavirus (COVID-19)-moral decision-making. *Br Dent J* 2020;228(7):503-505.
7. Sabino-Silva R, Jardim AC, Siqueira WL. Coronavirus COVID-19 impacts to dentistry and potential salivary diagnosis. *Clin Oral Investig* 2020;24(4):1619-1621.
8. Terwee CB, Jansma EP, Riphagen II, de Vet HC. Development of a methodological PubMed search filter for finding studies on measurement properties of measurement instruments. *Qual Life Res* 2009;18(8):1115-1123.
9. Fiorini N, Canese K, Starchenko G, Kireev E, Kim W, Miller V, Osipov M, Kholodov M, Ismagilov R, Mohan S, Ostell J. Best match: new relevance search for PubMed. *PLoS Biol* 2018;16(8):e2005343.
10. Walters WH. Google Scholar search performance: Comparative recall and precision. *Portal Libr Acad* 2009;9(1):5-24.
11. Downe-Wamboldt B. Content analysis: method, applications, and issues. *Health Care Women Int* 1992;13(3):313-321.
12. Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. *Afr J Emerg Med* 2017;7(3):93-99.
13. Graneheim UH, Lindgren BM, Lundman B. Methodological challenges in qualitative content analysis: A discussion paper. *Nurse Educ Today* 2017;56:29-34.
14. Lindgren BM, Lundman B, Graneheim UH. Abstraction and interpretation during the qualitative content analysis process. *Int J Nurs Stud* 2020;108:103632.
15. Connected Papers service. <https://www.connectedpapers.com/>. Accessed 15 May 2021.
16. Attia S, Howaldt HP. Impact of COVID-19 on the Dental Community: Part I before Vaccine (BV). *J Clin Med* 2021;10(2):288.
17. Horzov L, Goncharuk-Khomyn M, Hema-Bahyna N, Yurzenko A, Melnyk V. Analysis of tongue color-associated features among patients with PCR-confirmed COVID-19 infection in Ukraine. *Pesqui Bras Odontopediatria Clín Integr* 2021;21:0011.
18. Brian Z, Weintraub JA. Oral Health and COVID-19: Increasing the Need for Prevention and Access. *Prev Chronic Dis* 2020;17:E82.
19. Brandini DA, Takamiya AS, Thakkar P, Schaller S, Rahat R, Naqvi AR. Covid-19 and oral diseases: Crosstalk, synergy or association?. *Rev Med Virol* 2021;31(6):e2226.
20. Elster N, Parsi K. Oral health matters: The ethics of providing oral health during COVID-19. *Hec Forum* 2021;33(1-2):157-164.
21. Sardana D, Yiu CK, McGrath CP. Impact of COVID-19 on ongoing & ensuing dental research. *J Dent* 2021;106:103590.
22. Evans WD, French J. Demand Creation for COVID-19 Vaccination: Overcoming Vaccine Hesitancy through Social Marketing. *Vaccines* 2021;9(4):319.
23. Balaji SM. COVID-19 vaccination, dentistry, and general public. *Indian J Dent Res* 2020;31(6):829.
24. Shacham M, Greenblatt-Kimron L, Hamama-Raz Y, Martin LR, Peleg O, Ben-Ezra M, Mijiritsky E. Increased COVID-19 Vaccination Hesitancy and Health Awareness amid COVID-19 Vaccinations Programs in Israel. *Int J Environ Res Public Health* 2021;18(7):3804.
25. Kaplan AK, Sahin MK, Parildar H, Guvenc IA. The willingness to accept the COVID-19 vaccine and affecting factors among healthcare professionals: A cross-sectional study in Türkiye. *Int J Clin Pract* 2021:e14226.
26. Szymd B, Karuga FF, Bartoszek A, Staniecka K, Siwecka N, Bartoszek A, Błaszczak M, Radek M. Attitude and behaviors towards SARS-CoV-2 vaccination among healthcare workers: A cross-sectional study from Poland. *Vaccines* 2021;9(3):218.
27. Biswas N, Mustapha T, Khubchandani J, Price JH. The Nature and Extent of COVID-19 Vaccination Hesitancy in Healthcare Workers. *J of Community Health* 2021;1-8.
28. Bsoul EA, Loomer PM. COVID-19 vaccination experience among United States dental professionals and students: Safety, confidence, concerns, and side effects. *PloS one* 2022;17(2):e0264323.
29. Gurenlian JR, Eldridge LA, Estrich CG, Battrell A, Lynch A, Morrissey RW, Araujo MW, Vujicic M, Mikkelsen M. COVID-19 Vaccine Intention and Hesitancy of Dental Hygienists in the United States. *American Dental Hygienists' Association* 2022;96(1):5-16.
30. Kelekar AK, Lucia VC, Afonso NM, Mascarenhas AK. COVID-19 Vaccine Acceptance and Hesitancy Among Dental and Medical Students. *J Am Dent Assoc* 2021;152(8):596-603.
31. Mascarenhas AK, Lucia VC, Kelekar A, Afonso NM. Dental students' attitudes and hesitancy toward COVID-19 vaccine. *J Dent Educ* 2021;85(9):1504-1510.
32. Zhang J, Dean J, Yin Y, Wang D, Sun Y, Zhao Z, Wang J. Determinants of COVID-19 Vaccine Acceptance and Hesitancy: A Health Care Student-Based Online Survey in Northwest China. *Front Public Health* 2021;9:777565
33. Shakeel CS, Mujeeb AA, Mirza MS, Chaudhry B, Khan SJ. Global COVID-19 Vaccine Acceptance: A Systematic Review of Associated Social and Behavioral Factors. *Vaccines* 2022;10(1):110.
34. Cirillo N. Reported orofacial adverse effects of COVID-19 vaccines: The knowns and the unknowns. *J Oral Pathol Med* 2021;50(4):424-427.
35. Riad A, Pokorná A, Attia S, Klugarová J, Koščík M, Klugar M. Prevalence of COVID-19 Vaccine Side Effects among

- Healthcare Workers in the Czech Republic. *J Clin Med* 2021;10(7):1428.
36. Osborne V, Shakir SA. What Is the Difference Between Observed Association and Causal Association, Signals and Evidence? Examples Related to COVID-19. *Front Pharmacol* 2020;11:569189.
  37. Ward AC. The role of causal criteria in causal inferences: Bradford Hill's "aspects of association". *Epidemiol Perspec Innov* 2009;6(1):1-22.
  38. Zigran A, Dror AA, Morozov N, Shani T, Haj Khalil T, Eisenbach N, Rayan D, Daoud A, Kablan F, Sela E, Srouji S. COVID-19 vaccine acceptance among dental professionals based on employment status during the pandemic. *Front Med* 2021;8:618403.
  39. Serban S, Mustufvi Z, Kang J, Simon SE, Grant S, Douglas G. The dental team: an additional resource for delivering vaccinations. *Front Med* 2020;7:606242.
  40. Wright JT. COVID-19 vaccination: science, politics and public health. *J Am Dent Assoc* 2021;152(3):181-183.
  41. Derruau S, Bouchet J, Nassif A, Baudet A, Yasukawa K, Lorimier S, Prêcheur I, Bloch-Zupan A, Pellat B, Chardin H, Jung S. COVID-19 and Dentistry in 72 Questions: An Overview of the Literature. *J Clin Med* 2021;10(4):779.
  42. Wilson R, Jonke G. The ethics of dentists receiving the COVID-19 vaccine: Following the American Dental Association Principles of Ethics and Code of Professional Conduct. *J Am Dent Assoc* 2021;152(5):408-409.
  43. Guillén LE. The urgency of vaccination against Covid-19 in dentists. *RevCient Odontol* 2021;9(1):e040.
  44. Jain V, Schwarz L, Lorgelly P. A rapid review of COVID-19 vaccine prioritization in the US: alignment between Federal guidance and State practice. *Int J Environ Res Public Health* 2021;18(7):3483.
  45. Dawson J. The COVID-19 vaccine and the dental team. *BDJ in Pract* 2021;34(3):42.
  46. Melo P, Barbosa JM, Jardim L, Carrilho E, Portugal J. COVID-19 Management in Clinical Dental Care. Part I: Epidemiology, Public Health Implications, and Risk Assessment. *Int Dent J* 2021;S0020-6539(21)00034-4.
  47. Jamal M, Shah M, Almarzooqi SH, Aber H, Khawaja S, El Abed R, Alkhatib Z, Samaranyake LP. Overview of transnational recommendations for COVID-19 transmission control in dental care settings. *Oral Dis* 2021;27:655-664.
  48. Nijakowski K, Cieřlik K, Łaganowski K, Gruszczynski D, Surdacka A. The Impact of the COVID-19 Pandemic on the Spectrum of Performed Dental Procedures. *Int J Environ Res Public Health* 2021;18(7):3421.
  49. Ashraf M, Kim Y, Kumar S, Seo D, Ashraf M, Bae YS. COVID-19 vaccines (revisited) and oral-mucosal vector system as a potential vaccine platform. *Vaccines* 2021;9(2):171.
  50. Gao T, Ren Y, Li S, Lu X, Lei H. Immune response induced by oral administration with a *Saccharomyces cerevisiae*-based SARS-CoV-2 vaccine in mice. *Microb Cell Fact* 2021;20(1):1-10.
  51. Yoon W, Park Y, Kim S, Bang IS. Development of an Oral Salmonella-Based Vaccine Platform against SARS-CoV-2. *Vaccines* 2022;10(1):67.
  52. Sung JC, Liu Y, Wu KC, Choi MC, Ma CH, Lin J, He EI, Leung DY, Sze ET, Hamied YK, Lam DM. Expression of SARS-CoV-2 Spike Protein Receptor Binding Domain on Recombinant *B. subtilis* on Spore Surface: A Potential COVID-19 Oral Vaccine Candidate. *Vaccines* 2022;10(1):2.
  53. Wen W, Chen C, Tang J, Wang C, Zhou M, Cheng Y, Zhou X, Wu Q, Zhang X, Feng Z, Wang M. Efficacy and safety of three new oral antiviral treatment (molnupiravir, fluvoxamine and Paxlovid) for COVID-19 : a meta-analysis. *Ann Med* 2022;54(1):516-523.