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A large cross-sectional survey of COVID-19 vaccination willingness among healthcare students and professionals: reveals generational patterns.

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EDITOR COMMENTS: "One more revision - Note author guidelines state "Abstracts should be 300 words maximum, no abbreviations. Do not report p values, confidence intervals and other statistical parameters in the abstract" Please remove stats information - many thanks!"

Answer to the Editor:

Thank you for addressing this issue, as indicated, in the abstract we removed information on statistical parameters.

ABSTRACT

Aims: To determine COVID-19 vaccination hesitancy in healthcare professionals and healthcare students in Italy across four generations (baby boomers, generations X, Y, and Z).

Design: A cross-sectional descriptive study was performed through an online survey conducted from May to June 2021. The STROBE guidelines were adopted for reporting.

Methods: Data were collected by initially sending a survey link to a convenience sample of healthcare professionals and students, which was followed by snowball sampling. The VAX scale was validated and adopted. An ANOVA was performed to detect differences in vaccine-hesitancy beliefs between the four generational groups.

Results: The survey was completed by 1226 healthcare professionals and students. Worries about unforeseen future effects was the higher vaccination hesitancy factor across generations. More positive attitudes toward COVID-19 vaccination were expressed by members of generation Z than by members of generation Y and baby boomers. Members of generation X had the highest vaccination hesitancy scores in the overall scale.

Conclusion: The results suggest that public health campaigns should take into account the generational differences in COVID-19 vaccination hesitancy to achieve higher levels of vaccine acceptance, including among healthcare professionals and students.

Impact: Vaccination is the most effective strategy to tackle on the COVID-19 pandemic. The advice of health professionals strongly influences vaccination willingness in the general population. A consideration of the generational patterns in the COVID-19 vaccination hesitancy of healthcare workers and students may increase vaccination uptake in these populations, which in turn may lead to greater public acceptance of the vaccine.

Key words: nursing, COVID-19 vaccine, vaccine hesitancy, vaccination attitudes, vaccination adherence.

1. INTRODUCTION

The novel coronavirus SARS-CoV-2, which causes COVID-19 disease, was first described in December 2019. By March 2020, the World Health Organization (WHO) had declared a pandemic (WHO, 2020). To combat the spread of infection, governments and healthcare systems worldwide initially adopted several non-pharmacological measures, such as social distancing, suspension or modification of working activities, restricted movement, and the obligatory use of facial masks (Roma et al., 2020)). To conserve medical resources, patients with mild disease were managed at home and those with severe disease in the hospital. New therapeutic protocols (antiviral therapies, immune modulators, anticoagulants, monoclonal antibodies, and hyperimmune globulin) were also employed to treat disease severity or to prevent disease progression. However, none of these measures was particularly effective and the urgent need for a vaccine was quickly recognized (Mathieu et al., 2021).

Globally, as of 30 November 2021, there have been 261,435,768 confirmed cases of COVID-19, including 5,207,634 deaths. Over 4.28 billion people worldwide, corresponding to ~ 55.8% of the world population, have received at least one dose of a COVID-19 vaccine (World Health Organization [WHO], 2021), albeit with large differences among countries (Mathieu et al., 2021). The experience thus far has shown that vaccination against SARS-CoV-2 can mitigate COVID-19 severity and it is expected that it will flatten, delay, or prevent future epidemic waves of the disease.

1.1. Background

Although both the safety and the effectiveness of vaccination against SARS-CoV-2 are universally recognized (Center for Disease Control and Prevention [CDC], 2021) and countries worldwide are striving to achieve COVID-19 immunity within their populations, vaccination hesitancy remains a major obstacle both in the general population (Bhagianadh & Arora, 2021) and among healthcare workers and students (Holzmann-Littig et al., 2021). The reasons include concerns about vaccine

safety, a lack of trust in the government or in the healthcare system, and a suspicion of profiteering by pharmaceutical companies (Normura et al., 2021). These attitudes have been supported by the rapid dissemination of fake news regarding the risks of vaccination. Fake news is defined as "fabricated information that imitates news media content in form but not in organizational process or intent, which overlaps with other information disorders, such as misinformation - false or misleading information - and disinformation, which is false information that is deliberately disseminated to deceive people" (Lazer et al., 2018). The problem is compounded by the fact that fake news spreads faster and is more highly entrenched than real news, facilitated by the rapid propagation of information, regardless of its source or quality, by social media. The WHO (2020) has defined this overabundance of information as an "infodemic" that is spreading fear, uncertainty, and anxiety with respect to health-related behaviors. During the pandemic, it has resulted in a fragmented response that has hampered pandemic containment strategies. Public health measures adopted to stop the spread of the virus have been paralleled by the spread of various conspiracy theories (European Commission, 2020) that have not only encouraged a general distrust of healthcare systems but have also led to a robust anti-vaccine movement and in some instances to violent demonstrations, all of which have hampered efforts to achieve global immunization (Herrera-Peco et al., 2021).

Vaccine hesitancy on the part of healthcare workers (HCWs) has far-reaching impact. For ethical and scientific reasons this group should be promoters of vaccination (Squeri et al., 2017), given their interest in protecting both their patients and the global community. However, vaccination among HCWs has always been a controversial issue: for example, the coverage rate in HCWs for seasonal influenza vaccination in European countries from 2015 to 2018 was < 40% and in Italy it was < 20% (ECDC, 2018).

In the US, only one-third of HCWs were willing to be vaccinated with the COVID-19 vaccine as soon as it became available, prior to its Emergency Use Authorization (EUA), with a majority choosing to wait several months before deciding (Shekhar et al., 2021). Another study suggested that being a nondoctor healthcare personnel (i.e., nurse/midwife) was an independent risk factor for refusing or postponing COVID-19 vaccination, with the most common reasons for these decisions being doubt about the efficacy of the vaccine, distrust of its content, and a fear of side effects (Esen et al., 2021). Vaccine hesitancy in HCWs is an important issue due to its potential consequences for the HCWs themselves and because higher patient mortality rates were reported in hospitals with a lower percentage of vaccinated employees. In response, countries such as the US, Canada, Australia, and the UK have implemented policies whereby certain vaccinations are a legal requirement for HCWs. In Italy, a law was passed in April, 2021 requiring that all HCWs be vaccinated against COVID-19 or face unpaid suspension from work. The law is in effect until December 31, 2021, and it also includes healthcare students participating in clinical placements. In the case of COVID-19 vaccination, physicians and nurses in some countries have been suspended from hospital practice. These actions have been supported by the European Court of Human Rights in Strasbourg, which ruled that obligatory vaccination does not contravene the European Convention on Human Rights (Ważyńska-Finck, 2021).

In this study, we examined whether vaccine hesitancy among healthcare professionals and students is related to generational differences. Our study draws on recent work by Nomura et al. (2021), who showed that a public health campaign specifically targeting individuals with vaccine hesitancy may help to increase COVID-19 vaccine uptake. We hypothesized that a generation-specific approach, by building upon the cultural experiences, attitudes, values, and beliefs shared by a particular age group (Şenyuva, 2018), would be effective in addressing COVID-19 vaccine

hesitancy among HCWs and healthcare students and thus in promoting vaccine uptake by this population.

The recent healthcare literature recognizes four generations that differ in their professional and work-related attitudes, values, and beliefs: (1) the baby boomers (BB) generation values organizational loyalty and a strong work ethic; (2) generation X prioritizes a work-life balance; (3) generation Y is innovation-oriented and values change over stability; (4) generation Z is the first fully native digital generation and it has intensively integrated social media into everyday life (Schmitt et al., 2019). Our hypothesis is based on the assumption that these generational differences affect vaccination hesitancy, such that generational differences in professional and work-related attitudes, values, and beliefs should be considered in vaccination campaigns the healthcare professionals and students are exposed in taking care of vulnerable people and vaccination is supposed to contribute to patient safety at the individual and at the organizational level. Furthermore, the impact of the current COVID-19-related "infodemic" may differ in different generations. Thus, in this study, healthcare professionals and students in Italy distributed across four generations were assessed for their attitudes towards COVID-19 vaccination.

2. THE STUDY

2.1. Aims

The aim of this study was to reveal possible generational differences in attitudes towards COVID-19 vaccination in HCWs and healthcare students in Italy.

2.2. Design

A cross-sectional, descriptive study was performed from May to June 2021, through an online survey of HCWs and healthcare students in Italy. The study period coincided with the third wave

of the COVID-19 pandemic. The STrengthering the Reporting of Observational studies in Epidemiology (STROBE) guidelines were adopted for reporting.

2.3. Participants

Healthcare professionals and students were recruited in a convenience sampling approach, via formal and informal networks throughout Italy. The online survey was initially disseminated within healthcare professionals' and students' associations and social networks groups at the national level. Snowball sampling contributed to further dissemination of the survey among the target population. Participants were categorized into generations according to the following criteria, drawn from the literature: BB participants were born between 1946 and 1964; generation X participants between 1965 and1980, generation Y participants between 1981 and 1996, and generation Z participants after 1997 (Schmitt et al., 2019).

2.4. Data collection

Data were collected in an online survey approach implemented in LimeSurvey. To prevent inappropriate accesses, a CAPTCHA system was adopted to prevent inappropriate accesses: in detail participants were asked to report the sum score of a basic operation, thus confirming that the participant was human and not an internet-bot. A cookies recording system was also adopted to prevent duplicated or multiple imputations from the same user's device.

2.5. Ethical considerations

Data collection and analysis were designed to ensure data confidentiality and were conducted in accordance with national and European laws (GDPR, 2018) and the Personal Data Act (523/1999). The electronic data were saved in a protected folder, accessible only by the principal investigator. The survey platform was protected by a strong-recognized password and a two-step authentication method. On the first screen of the survey, participants were shown a statement that included details of the study and data handling. Survey submission was interpreted as the participant's consent.

Due to the type of data collected and the online data collection approach, neither ethical approval nor administrative permissions were necessary.

The online survey was designed according to the Code of Ethics of the American Association for Public Opinion Research (AAPOR, 2021). The participation was voluntary to all participants and in compliance with the standards of informed consent, data confidentiality and anonymity (EU 2016/679). Due to the type of data collected, the data collection approach and the descriptive design of the study, neither administrative nor ethical approvals were necessary (Decreto del Ministero della Salute, 2013).

2.6. Measures

2.6.1. Instrument description

The VAX scale consists of 12 items rated on a Likert scale of agreement, ranging from one (strongly disagree) to seven (strongly agree) (Martin & Petrie, 2017). In this study, it was used with respect to COVID-19 vaccination. The 4-factors model was based on previous psychometric testing and included: mistrust of vaccine benefit (3 items); worries about unforeseen future effects (3 items); concerns about commercial profiteering (3 items); and preference for natural immunity (3 items) (Martin & Petrie, 2017). Lower scores were considered to reflect a more positive attitude toward the vaccine. The "mistrust of vaccine benefit" factor was defined as the reversed score of the following items: "I feel safe after being vaccinated", "I can rely on vaccines to stop serious infectious diseases", and "I feel protected after getting vaccinated."

Socio-demographic, work-related (i.e., work or placement in a COVID area), and health-related (COVID infection exposure) data were collected to further describe the sample (see supplementary file S1).

2.7. Data analysis

The data were analyzed using Stata v12 (StataCorp., 2011). Multivariate outliers were checked by adopting the "bacon" package in Stata v12. Descriptive statistics were calculated to describe the sample. VAX scale scores were calculated as the mean and standard deviation (SD) for the total scale and for each factor. Statistical differences were detected by performing an ANOVA for the VAX scale and its factors by generation. Statistical significance was defined as a p-value <0.05. The survey was designed such that answers were mandatory for all items of the VAX scale, while, the socio-demographic were not mandatory; missing data management was not necessary.

2.7.1. Sample size

For a confirmatory factor analysis (CFA), a participant to parameter ratio ranging from 10:1 to 20:1 is recommended (Kline, 2015;). Accordingly, the required sample size was between 120 and 240 participants. Thus, to detect a statistically significant difference among the four generational groups based on an ANOVA and by considering an alpha error of 0.05 and a power of 0.99, the minimum sample size for our study was 384 participants.

2.8. Validity, reliability, and rigor

2.8.1. Content validity

A panel of four researchers fluent in Italian and English performed a forward and backward translation to ensure content validity. The panel achieved agreement on the Italian translation of the scale; neither the deletion of an item nor the cultural adaptation of an item was needed. The Italian version was blindly back-translated into English by a native English speaker. Finally, the original English version and the English back-translated version were blindly compared by another researcher, fluent in English and familiar with the topic. The third independent researcher stated the content equivalence of the two versions and therefore the content validity of the Italian translation as well.

2.8.2. Validity and reliability

Cronbach's alpha was adopted to test instrument reliability. Values >0.90 are considered excellent, values >0.70 and ≤0.90 good, values >0.60 and ≤0.70 acceptable, and values ≤0.60 non-acceptable (DeVellis, 2016). A CFA was performed to test the VAX scale's construct validity. Fit indices were calculated to confirm the model's validity. Those indices are considered acceptable for a RMSEA (root mean square error of approximation) and SRMR (standardized root mean residual) <0.08, and based on a CFI (comparative fit index) and TLI (Tucker-Lewis Index) >0.90 (Kline, 2015).

3. RESULTS

The survey questionnaire was completed by 1226 healthcare students and healthcare professionals. The majority were female (75.5%; 926/1226) and the mean age was 30.1 years (SD=12.42; median=24; min=20; max=70). Healthcare students comprised 58.0% of the sample (711/1226) and healthcare professionals the remainder. Among the former, most were nursing students (84.4%; 600/711); 15.6% included students in medicine, dentistry, psychology, pharmacy, or technical areas (e.g., lab or X-ray technicians). Healthcare professionals made up 42.0% (515/1226) of the study population; the majority were nurses (430/515; 83.5%) and the others either physicians or technicians (e.g., lab or X-ray technicians).

According to the generational distribution, 4.9% (60/1226) were BB, 17.4% belonged to generation X (213/1226), 27.1% (332/1226) to generation Y, and 50.6% (621/1266) to generation Z. A clinical placement in a COVID-19 clinical setting in the last 12 months was reported by 6.0% (43/711) of the healthcare students; 45.6% (235/515) of the healthcare professionals had worked in a COVID-19 area in the last 12 months. Overall, 13.6% (167/1226) of the total sample reported infection with COVID-19 and 83.8% (1027/1226) never having been infected. Data were missing

for 2.6% (32/1226). Most of the participants (64.4%; 790/1226) also reported living with or caring for a frail person in their close family network (Table 1).

No multivariate outliers were detected in the data distribution. The CFA and fit indexes confirmed the previously determined 4-factors model: RMSEA=0.068 (90% confidence interval [CI] =0.061–0.075), SRMR=0.045, TLI=0.947, CFI=0.962. Cronbach's alpha was 0.88 in the overall scale and ranged from 0.75 to 0.84 among factors. Both the validity and the reliability of the scale were confirmed.

Based on the descriptive statistics, the overall mean value for the VAX scale was 2.78 (SD=0.93, median=2.67; min=1; max=7). For 25% of the sample the score was below 2.17 (Q1) and for 25% it was over 3.25 (Q3). The overall mean score of the factor "mistrust of vaccine benefit" was 1.92 (SD=0.97; median=1.67; min=1; max7). For 25% of the sample the score was below 1.33 (Q1) and for 25% it was over 2.00 (Q3). The mean score of the factor "worries about unforeseen future effects" was 4.31 (SD=1.29, median=4.33; min=1; max=7). For 25% of the sample the score was below 2.67 (Q1) and for 25% it was over 5.33 (Q3). The mean score of "concerns about commercial profiteering" was 2.14 (SD=1.26; median=1.67; min=1; max=7). For 25% of the sample the score was below 1.00 (Q1) and for 25% it was over 2.67 (Q3). The mean score of the "preference for natural immunity" factor was 2.73 (SD=1.30; median=2.67; min=1; max=7). For 25% of the sample the score was below 1.67 (Q1) and for 25% it was over 3.67 (Q3).

Among the four studied generations, generation Z had the lowest score in the overall VAX scale and thus a highly positive attitude toward COVID-19 vaccination (mean=2.62; SD=0.79; median=2.50; min=1; max=7; Q1=2.08; Q3=3.00). The highest score and thus the most negative attitude toward vaccination was that of generation X (mean=3.00; SD=1.04; median=2.83; min=1;

max=7; Q1=2.33; Q3=3.58). The difference between these generations was statistically significant (F=13.32, p<0.001).

The same pattern was detected when the generations were compared for each factor; the differences in the mean scores were statistically significant. The factor "worries about unforseen future effects" consistently had the highest score, ranging between a mean of 4.15 (SD=1.20; median=4.33; min=1; max=7; Q1=3.33; Q3=5.00) in the generation Z group and a mean of 4.59 (SD=1.32; median=4.67; min=1; max=7; Q1=4.00; Q3=5.33) in the generation X group. The scores for the factor "preference for natural immunity" were similar for BB, generation X, and generation Y: 2.92 (SD=1.28; median=2.83; min=1; max=7; Q1=2.00; Q3=3.67), 2.89 (SD=1.37; median=2.67; min=1; max=7; Q1=2.00; Q3=4.00), and 2.87 (SD=1.41; median=2.67; min=1; max=7; Q1=2.00; Q3=3.83), respectively. Overall, the differences in the scores of generation X were higher and those of generation Z lower than the scores of BB and generation Y. The mean scores and inferential statistics are reported in Table 2.

3.1. Sensitivity analysis

Given the differences in the generational distribution of healthcare students vs. healthcare professionals, the data of the two groups were analyzed separately.

Among healthcare professionals, generation Z participants had a more positive (mean=2.48; SD=0.67) and generation Y a more negative attitude (mean=2.98; SD=1.06) toward vaccination, while among healthcare students the highest score, indicating the most negative attitude, was that of the two BB members (mean=3.41; SD=0.35). The mean of the VAX scale total score differed signifincantly for both healthcare professionals (p=0.008) and healthcare students (p=0.007). Statistically significant generational differences were also detected among healthcare students for the factors "mistrust of vaccine benefit" (p<0.001) and "worries about unforeseen future effects"

(p=0.036), and among healthcare professionals for the factors “mistrust of vaccine benefit” (p=0.022) and “concerns about commercial profiteering” (p=0.015). The mean scores and results of the statistical analyses for the two groups are reported in Tables 3 and 4.

4. DISCUSSION

This is the first study to explore generational differences in the hesitancy of healthcare professionals and students in Italy regarding vaccination against COVID-19. Overall, our findings revealed a high vaccine hesitancy across all four studied generations, largely due to concerns about unforeseen future effects. Previous studies found that vaccine safety issues were the most important determinant of COVID-19 vaccine hesitancy in HCWs (Li et al., 2021;), college students (Salerno et al., 2021), and the general population (Reiter et al., 2020). Possible explanations for the concerns of HCWs are: (1) misinformation transmitted on social media, (2) limited resources, increased workload, and (3) inadequate information on the risks or benefits of the vaccine (Paterson et al., 2016).

Our identification of these concerns and their sources suggests strategies for addressing vaccine hesitancy in healthcare professionals and students, including a greater focus on the long-term safety of the vaccine that draws on scientific evidence. Building confidence in vaccines, and in their efficacy and safety in particular, may in turn contribute to both groups recommending the vaccine to others. A previous study showed that the advice of HCWs is highly trusted by their patients, including with respect to vaccination, especially if they themselves have been vaccinated or intend to be vaccinated (Paterson et al., 2016). HCWs were shown to act as role models for the population and to have a positive influence on patients' vaccination attitudes (Burden et al., 2021). Vaccinated HCWs are more likely to recommend vaccination to patients and, in general, to others,

whereas doubtful or hesitant HCWs may be reluctant to recommend vaccination to either their patients or members of their community.

In the development of efforts to increase the acceptability of the COVID-19 vaccine, several factors must be taken into account, including contextual influences, vaccine-specific issues, individual/social group influences, and personal values, as all of these will guide individual decision-making (Şenyuva, 2018). Health beliefs related to vaccination are influenced by perceptions of the risk and severity of the respective disease as well as the efficacy, safety, and potential side effects of the vaccine. Previous studies suggested an association with the acceptability of vaccines such as the seasonal influenza vaccine (Ling et al., 2019) and the human papillomavirus vaccine (Reiter et al., 2009). However, personal beliefs are dynamic and modifying them can affect behavior, which should be borne in mind in future educational interventions and vaccination campaigns against COVID-19. This approach has been successfully used to improve knowledge, attitudes, and uptake of other vaccines (McRee et al., 2018).

That vaccine acceptance vs. hesitancy is closely related to the level of knowledge about the vaccine and the source of information was demonstrated by Gallè et al. (2021) in a study of Italian undergraduate students. Therefore, an analysis of vaccine acceptance among different groups within a population may result in more effective and more informative campaigns to counteract disinformation.

Among HCWs, several interventions were shown to be effective in increasing both the rate of influenza vaccination and trust in the healthcare system. These included educational talks/videos, an extensive educational campaign, informed consent, audit and telephone interviews with unvaccinated HCWs, a medical interview with a hospital executive regarding noncompliance, and visible leader support (Paterson et al., 2016). However, given the many possible forms of active

vaccine advocacy, an assessment of generational differences in vaccine acceptance can shed light on the strategies most likely to increase the COVID-19 vaccination rate in healthcare professionals and healthcare students.

4.1. Comparison between generations

Our study identified a more positive attitude toward COVID-19 vaccination in generation Z than in the other generations. Generation Z was also the youngest generation in our study and its willingness to be vaccinated may be related to a desire for an active social life, freedom of daily movement, and travel. In addition, as a digitally savvy generation, generation Z may be less susceptible to fake news and thus better able to recognize reliable information about vaccination.

As future healthcare providers, healthcare students generally have a high level of e-Health literacy and are therefore skilled in locating, using, and critically appraising health information online, which in turn would improve their competency in decision-making. However, while students may be confident in obtaining information on the internet, they often lack the knowledge needed to make decisions about their own health options. This point deserves attention as previous studies have pointed out that vaccine acceptance and knowledge are closely related, thus emphasizing the key role of correct information in countering vaccination hesitancy (Gallè et al., 2021).

A positive attitudes toward COVID-19 vaccination was also identified in generation Y, consistent with the openness of this generation to innovation and change, especially as “the first generation of digital natives” (Palfrey & Gasser, 2008). Generation Y is characterized by a high level of confidence in using e-Health information, a recognition of reliable online resources, experience in working in healthcare settings, and a high degree of professionalism, all of which lead to balanced health-related decision-making.

The attitude of BB to COVID-19 vaccination was better than that of generation X or Y, in line with the work ethic, orientation towards the common good, and the strong sense of social responsibility that distinguishes this older generation (Şenyuva, 2018). The general lack of digital competency of BB is compensated by a high level of institutional commitment, including with respect to vaccination. In previous studies, increasing age was identified as an independent predictor of vaccination acceptance), perhaps because older age is also associated with a high risk of comorbidities, resulting in a higher risk tolerance by BB than by HCWs in younger age groups. Vaccination willingness in generation X was between that of BB and generation Y. Members of generation X, while digitally competent, lack institutional commitment, are more oriented to independent work, and have a general resistance to authority (Schmitt et al., 2019). These characteristics are consistent with our finding of a higher vaccine hesitancy in this group.

The generational differences detected in our study demonstrate the need for communication channels tailored to reach people of different generations and thus ensure the effective delivery of information. For example, while informal discussions through face-to-face or written communication are likely to be effective in BB, members of generations X, Y, and Z may be best reached through technology. However, differences between the latter generations should also be considered. For generations Y and Z, immediate feedback is important, given that their members mainly communicate through instant messaging, whereas generation X is likely to be more receptive to a dialectic form of communication, such as a more direct involvement in the public debate.

A vaccination campaign that takes into account the generational differences among healthcare professionals and students, especially their choice of communication channels, may result in improved communication and more effective content. Particular attention should be paid to the

methods used to reach members of generation X, as the high level of skepticism and individualism of this group (Kupperschmidt, 2000) may translate into a higher level of vaccine hesitancy. Accordingly, communication with generation X should be aimed at reducing concerns about unforeseen future effects of vaccination (Reiter et al., 2020). By contrast, for generation Z, a cohort likely to be more open to vaccination, the focus should be on behavioral recommendations and vaccine efficacy (Reiter et al., 2020). The preference for natural immunity was similar among BB and members of generations X and Y, indicating that for this issue the same message can be developed but its delivery will require different marketing strategies.

The consequences of the generational differences underlying vaccine hesitancy were demonstrated in a comparison of healthcare professionals vs. healthcare students. Vaccine hesitancy in healthcare professionals was related to a "mistrust of vaccine benefit" and to "concerns about commercial profiteering," whereas in healthcare students it was related to "mistrust of vaccine benefit" and to "worries about unforeseen future effects." This difference highlights the importance of targeting vaccination campaigns aimed at specific populations.

Profiling HCWs and healthcare students' vaccination hesitancy according to the generational category contributes to tailoring the COVID-19 vaccination campaign and to potentially increase vaccination uptake among the reluctant clusters. Consequently, by implementing a new vaccination approach based on attitudes, values, and beliefs in different age groups, the decision- and policy- makers can tackle vaccination uptake and public health strategies in a tailored way, so to overcome vaccination hesitancy. Moreover, our findings provide useful insights to further designing intervention studies to implement tailored educational strategies in the vaccination campaigns.

4.2. Strengths and limitations of the study

While generational differences in work environments have been examined in many studies, to our knowledge this is the first study to examine intergenerational differences in healthcare professionals and students with respect to COVID-19 vaccination. A particular strength of this study was the large sample, obtained by employing a mixed approach to sampling and survey dissemination.

Nonetheless, the limitations of the study must also be noted. First of all, because the survey was online-based, those population groups less likely to engage in online communication and/or to have less access to the internet may have been under-represented. Furthermore, self-selection bias must be considered, as healthcare professionals and students with a greater propensity to be vaccinated might have been more likely to participate. Also, due to the cross-sectional design of the study, differences among groups, but not their causal relationships, were identified. Finally, our quantitative approach may have missed some aspects of the attitudes, values, and beliefs regarding vaccination against COVID-19: these might be better understood in a qualitative approach.

5. CONCLUSION

Addressing the generational differences in attitudes, values, and beliefs that lead to vaccine hesitancy in HCWs and healthcare students may contribute to generationally tailored COVID-19 vaccination campaigns and thus potentially to increased vaccination uptake among reluctant groups. Vaccine hesitancy within the healthcare community may best be overcome through vaccination campaigns that directly address the long-term safety of the vaccine, based on scientific evidence. However, the vaccination-related concerns of BB and members of generations Y and Z were shown to differ from those of generation X. Recognition of these differences in the

development of effective information and educational strategies could help institutions to achieve higher levels of vaccine uptake among healthcare professionals and students.

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Conflict of interest statement

No conflict of interest has been declared by the author(s).

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Table 1. Sample description.

	Healthcare students (N=711)	Healthcare professionals (N=515)	Total (N=1266)
Baby boomers	2 (0.28%)	58 (11.26%)	60 (4.74%)
Generation X	16 (2.25%)	197 (38.25%)	213 (16.82%)
Generation Y	126 (17.72%)	206 (40.00%)	332 (26.22%)
Generation Z	567 (79.74%)	54 (10.49%)	621 (49.05%)
Nursing	600 (84.39%)	430 (83.50%)	1030 (81.36%)
Other disciplines	111 (15.61%)	85 (16.50%)	196 (15.48%)
Exposed to COVID-19 in a clinical setting	43 (6.05%)	235 (45.63%)	278 (21.96%)
SARS-CoV-2 infection†	77 (11.16%)	90 (17.86%)	167 (13.62%)
Next of kin - frail person	471 (66.24%)	319 (61.94%)	790 (62.40%)

†32 missing values (21 healthcare students and 11 healthcare professionals).

Table 2. Generational differences in vaccine-hesitant beliefs (ANOVA).

	Generation					
	Baby boomers (N=60) mean (SD)	**X (N=213) mean (SD)**	**Y (N=332) mean (SD)**	**Z (N=621) mean (SD)**	**F**	**p-value**
MISTRUST OF VACCINE BENEFIT	1.82 (0.87)	2.10 (1.16)	2.07 (1.12)	1.79 (0.80)	9.39	**<.001**
WORRIES ABOUT UNFORESEEN FUTURE EFFECTS	4.48 (1.47)	4.59 (1.32)	4.43 (1.37)	4.15 (1.20)	7.88	**<.001**
CONCERNS ABOUT COMMERCIAL PROFITEERING	2.35 (1.18)	2.41 (1.40)	2.28 (1.42)	1.95 (1.10)	9.98	**<.001**
PREFERENCE FOR NATURAL IMMUNITY	2.92 (1.28)	2.89 (1.37)	2.87 (1.41)	2.58 (1.21)	5.57	**<.001**
VAX scale score	2.89 (0.94)	3.00 (1.04)	2.91 (1.03)	2.62 (0.79)	13.32	**<.001**

Table 3. Generational differences in vaccine-hesitant beliefs among healthcare students (ANOVA).

	Generation					
	Baby boomers (N=2) mean (SD)	**X (N=16) mean (±SD)**	**Y (N=126) mean (SD)**	**Z (N=567) mean (SD)**	**F**	**p-value**
MISTRUST OF VACCINE BENEFIT	2.00 (0.00)	2.73 (1.65)	1.97 (1.10)	1.80 (0.80)	6.76	**<.001**
WORRIES ABOUT UNFORESEEN FUTURE EFFECTS	5.33 (0.47)	4.81 (1.26)	4.37 (1.28)	4.16 (1.21)	2.85	**0.036**
CONCERNS ABOUT COMMERCIAL PROFITEERING	3.00 (0.94)	2.64 (1.49)	2.08 (1.26)	1.97 (1.10)	2.54	0.056
PREFERENCE FOR NATURAL IMMUNITY	3.33 (0.94)	2.71 (1.26)	2.71 (1.41)	2.59 (1.21)	0.60	0.614
VAX scale	3.41 (0.35)	3.22 (1.06)	2.78 (0.97)	2.63 (0.80)	4.10	**0.007**

Table 4. Generational differences in vaccine-hesitant beliefs among healthcare professionals (ANOVA).

	Generation					
	Baby boomers (N=58) mean (SD)	**X (N=197) mean (SD)**	**Y (N=206) mean (SD)**	**Z (N=54) mean (SD)**	**F**	**p-value**
MISTRUST OF VACCINE BENEFIT	1.81 (0.88)	2.04 (1.10)	2.13 (1.12)	1.70 (0.70)	3.23	**.022**
WORRIES ABOUT UNFORESEEN FUTURE EFFECTS	4.45 (1.48)	4.57 (1.33)	4.47 (1.42)	4.03 (1.07)	2.25	.082
CONCERNS ABOUT COMMERCIAL PROFITEERING	2.33 (1.19)	2.39 (1.39)	2.40 (1.50)	1.75 (0.99)	3.52	**.015**
PREFERENCE FOR NATURAL IMMUNITY	2.91 (1.30)	2.91 (1.38)	2.97 (1.40)	2.45 (1.18)	2.10	.099
VAX scale score	2.87 (0.95)	2.98 (1.04)	2.99 (1.06)	2.48 (0.67)	4.00	**.008**

Supplementary file 1 (S1) - List of survey items and response options.

Vax scale items:

1. I feel safe after being vaccinated

2. I can rely on vaccines to stop serious infectious diseases.

3. I feel protected after getting vaccinated.

4. Although most vaccines appear to be safe, there may be problems that we have not yet discovered.

5. Vaccines can cause unforeseen problems in children.

6. I worry about the unknown effects of vaccines in the future.

7. Vaccines make a lot of money for pharmaceutical companies, but do not do much for regular people.

8. Authorities promote vaccination for financial gain, not for people's health.

9. Vaccination programs are a big con.

10. Natural immunity lasts longer than a vaccination.

11. Natural exposure to viruses and germs gives the safest protection.

12. Being exposed to diseases naturally is safer for the immune system than being exposed through vaccination.

Liket scale:
1=Strongly disagree; 2=disagree; 3=slightly disagree; 4=Neither agree nor disagree; 5=slightly agree; 6=agree; 7=strongly agree.

Sociodemographic (response options):

- Gender (Male/Female).

- Age (Years).

- Student or healthcare professional [student, fill in the response options (nursing, medicine, dentistry, psychology, pharmacy or technical area); healthcare professionals: fill in the response options (nursing, medicine, dentistry, psychology, pharmacy or technical area)].

- For students - Have you attended a clinical placement in a COVID-19 clinical setting in the last 12 months? (Yes/No).

- For healthcare professionals – Have you worked in a COVID-19 clinical setting in the last 12 months? (Yes/No).

- Have you been infected by COVID-19? (Yes/No).

- Do you live with or caring for frail person in your close family network? (Yes/No).

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	7-9
		(*c*) Explain how missing data were addressed	6,9
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7-9
		(*e*) Describe any sensitivity analyses	7-9, 11
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6,7
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4,5
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	9-11

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	9-11
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15,16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	11-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	✓

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.