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Trust of Italian healthcare professionals in COVID-19 (anti-SARS-COV-2) vaccination

Z. Di Valerio[1], M. Montalti[1], F. Guaraldi[2], D. Tedesco[3], B. Nreu[4], E. Mannucci[4] M. Monami[4], D. Gori[1]

Key words: Vaccine hesitancy, healthcare professionals, COVID-19, SARS-CoV-2, vaccine, vaccine confidence

Parole chiave: Esitazione vaccinale, operatori sanitari, COVID-19, SARS-CoV-2, vaccino, adesione vaccinale

Abstract

Background. Vaccination is one of the most effective tools available to Public Health. Its potential usefulness is threatened by the rise of vaccine hesitancy among the general population, which has grown as much as to prompt the World Health Organization to express its concerns on the matter. The risk posed by vaccine hesitancy is even more concerning in the light of the efforts to curb the ongoing COVID-19 pandemic, which focus mainly on mass vaccination campaigns. This holds especially true when applied to healthcare professionals, among whom vaccine hesitancy can be particularly detrimental. For these reasons, our study focuses on potential determinants of vaccine hesitancy among healthcare professionals.

Study design. The study is a cross-sectional study.

Methods. Data were collected from January 1st to February 16th, by means of a self-administered online questionnaire in a cohort of Italian healthcare professionals.

Results. Overall, 10,898 questionnaires were collected. Among the respondents, 1.1% expressed vaccine hesitancy. Hesitancy was less frequent in professionals involved in Primary Care and in the Clinical Sciences/Public Health group. Among clinicians, paediatricians, oncologists, and geriatrists showed especially accepting attitudes towards vaccination. Lower hesitancy rates were also registered among the respondents who already had received influenza vaccination and who never had any adverse effects following vaccination. Higher hesitancy rates were observed among individuals who had family members aged >65 years and with a history of severe adverse reactions to vaccination.

Conclusion. Vaccine hesitancy rates were extremely low among participants in our study. Some medical specialties shown were particularly accepting towards vaccination. The potential predictors and protective factors pointed out by our analysis might allow more refined targets

[1] *Department of Biomedical and Neuromotor Sciences (DIBINEM) University of Bologna, Bologna, Italy*

[2] *IRCCS Istituto delle Scienze Neurologiche di Bologna, Bologna, Italy*

[3] *Regional Authority for Healthcare and Welfare, Emilia-Romagna Region, Bologna, Italy*

4 Diabetology Unit, Careggi Hospital, and University of Florence, Florence, Italy

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Introduction

Vaccination is one of the most successful public health measures as it can potentially eradicate or significantly reduce the diffusion and clinical severity of communicable diseases (1). However, vaccination effectiveness requires widespread and stable acceptance by the general population, so to reach and maintain herd immunity, prevent outbreaks of communicable diseases, and ensure the prompt diffusion and administration of new vaccines (2).

The important reduction in people adherence to vaccination registered worldwide has prompted the World Health Organization (WHO) to list it among the most pressing global health concerns in 2019 (3). Vaccine hesitancy (VH) has been defined by the Strategic Advisory Group of Experts on Immunization (SAGE) as the "delay in acceptance or refusal of vaccination, despite the availability of vaccination services" (4), thus encompassing the whole spectrum of negative attitudes towards vaccination, from utter opposition to reluctant acceptance.

The 2020 COVID-19 pandemic has made the VH issue even more pressing, since an effective treatment has yet to be devised, and the efforts to curb the impact of the disease heavily rely on timely and effective vaccination campaigns.

Several studies have shown that COVID-19 vaccine acceptance rates largely vary worldwide, depending on an array of factors, including strength of confidence in the government, and concerns about vaccine safety and effectiveness (5). In many countries, rates under 60% have been reported, corresponding to an insufficient proportion of immune individuals needed to halt the transmission and spread of the virus in the population (60-75%) (6, 7). The lowest acceptance rates were registered in Eastern European countries, Russia and North Africa, while they largely varied among Western European countries, the highest (80%) being reported in Denmark, and the lowest (53.7%) in Italy (8).

The increase of VH rate also among healthcare workers (9-12) is particularly worrying, as a vulnerable hospital workforce could threaten the effective handling of COVID-19 patients, and also because of the pivotal role that healthcare professionals should have in tackling VH by addressing patient concerns and by spreading correct information about benefits of immunization and potential adverse effects associated with vaccination. Therefore, understanding the prevalence and causes of this phenomenon is of the utmost importance.

Based on these premises, this study aims at assessing rates of VH toward COVID-19 vaccine among healthcare professionals, and at identifying potential differences among specific subgroups, and predictors.

Methods

Data were collected by a web-based, self-administered questionnaire (Supplementary Material – Questionnaire), from January 1st to February 16th, 2021, filled by Italian healthcare professionals, members of a Facebook private group. Possession of the working license to practice in the healthcare system was verified on admittance.

The questionnaire consisted of 3 different sections aimed at: 1) collecting relevant demographic, epidemiological and medical information, including age, gender, Italian region of origin (also of his/her family), previous COVID-19 diagnosis, adherence to seasonal influenza vaccination, and potential adverse events following previous vaccinations; 2) exploring the attitude toward COVID-19 vaccination; and 3) focusing on potential adverse events occurring after COVID-19 vaccination. The question investigating the willingness to accept any COVID-19 vaccination asked participants, should they be negative, to

Supplementary Material - Questionnaire

Survey on VH for anti-COVID vaccines among Healthcare professionals

Item investigated

- Age
- Gender
- Educational Level
- Italian region of origin
- Pregnancy/breastfeeding
- Living with people aged ≥ 65 years
- Diabetes Mellitus
- Certified contraindications to vaccination
- Previous COVID-19 infection
- Flu vaccination in the previous year
- Adverse effects following past vaccinations
- Group of health professional
- **Do you intend to get vaccinated for COVID?**
- Reasons for intending (or not intending) to get vaccinated

express the reasons for their refusal, offering an array of options. An "Other" option was added to offer the chance to express any reasons for refusal not included among the other answers.

Data from section 1 and 2 only were retrieved and analysed for the purposes of this study.

The questionnaire was anonymous, and no system was put in place to prevent multiple replies. Participants were not given any incentive to fill in the questionnaire. Consent to participate in this study was requested upon access to the questionnaire, if the interviewee denied consent, data were not collected and the questionnaire page closed. No advice from an Ethical Committee was requested, as all the data were collected anonymously, analyzed as aggregated data and the analysis did not involve any experimental research in human subjects reporting certified contraindications to vaccination, as well as pregnant or breastfeeding women, were excluded.

Data were collected using Microsoft Excel (Microsoft Corporation). All statistical analyses were performed using STATA version 15.1 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

Univariate analysis was used to test the association between VH and age groups, professional clusters, and professions. A multivariate analysis was performed for VH, using variables significantly associated with VH at univariate analysis as putative moderators, with a stepwise logistic regression model. Chi2 tests were used to assess between-group differences.

Results

Overall, 11,078 questionnaires were collected, but data from 10,898 only could be analysed, since 180 participants denied informed consent to study participation (Table 1).

One hundred twenty-two (1.1%) expressed concerns towards all types of COVID-19 vaccination, while 175 (1.6%) reported certified contraindications to vaccination.

According to uni- and multivariate analysis, VH resulted lower in people employed in Primary Care and Clinical Sciences/Public

Table 1 - Main demographic and clinical features of the subjects included in the study (N= 10,898)

Feature		N (%)
Age (years)	18-30	1,207 (11.1)
	31-40	3,404 (31.2)
	41-50	2,765 (25.3)
	51-60	1,984 (18.2)
	61-70	1,449 (13.3)
	71-80	78 (0.7)
	81+	11 (0.1)
Gender	Male	2,410 (22.1)
	Female	8,488 (77.9)
Pregnancy/breastfeeding	Yes	43 (0.4)
	No	10,855 (99.6)
Italian region of origin	North-western	2,390 (21.9)
	North-eastern	2,013 (18.5)
	Central	3,375 (31)
	Southern	1,744 (16)
	Insular	1,376 (12.6)
Living with people aged ≥ 65 years	Yes	2,252 (20.7)
	No	8,646 (79.4)
Diabetes Mellitus	Yes	374 (3.4)
	No	10,503 (96.6)
Certified contraindications to vaccination	Yes	83 (0.8)
	No	10,815 (99.2)
Previous COVID-19 infection	Yes	760 (8.4)
	No	8,310 (91.6)
Flu vaccination in the previous year	Yes	7,852 (72.1%)
	No	3,032 (27.9%)
Adverse effects following past vaccinations	Yes	1,287 (12.2)[a]
	No	9,246 (87.8)
Vaccinated against COVID-19	Yes	10,512 (96.5)
	No	260 (2.4)

[a] Mild 1,215 (11.5%); severe 72 (0.7%)

Table 2 - Vaccine Hesitancy (VH) in the different groups of healthcare professionals

Discipline	OR	p-value	[95% CI]
Clinical Sciences/Public Health[a]	0.28	0.017	0.10-0.80
Medical specialty[b]	0.50	0.143	0.20-1.26
Surgical specialty[c]	0.55	0.239	0.20-1.48
Primary Care Physicians	0.32	0.037	0.11-0.93
Unspecialized physicians	0.71	0.586	0.20-2.47
Dentists	0.79	0.700	0.24-2.62
Medical students	0.77	0.726	0.18-3.28
Other healthcare professionals	0.33	0.100	0.09-1.24
Other professionals	1		

[a]The Clinical Sciences/Public Health cluster includes physicians employed in fields such as Clinical Biochemistry and Microbiology, and of course Hygiene and Public Health; [b]Includes physicians with clinical specialties; [c]Includes physicians with surgical specialties.

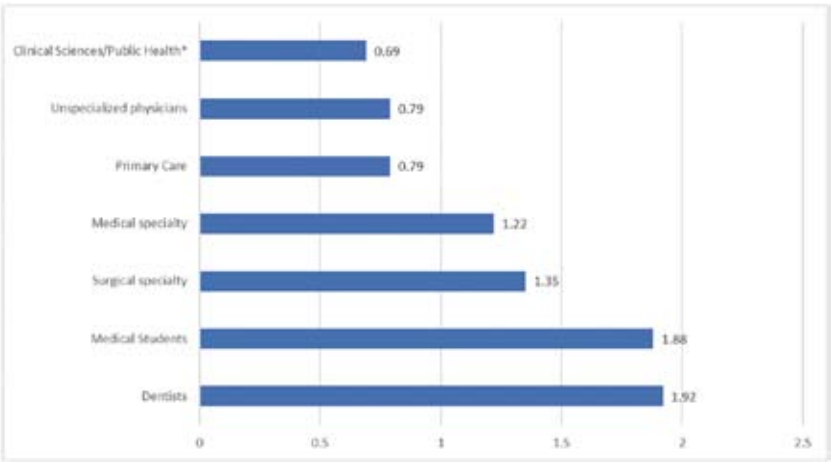

Figure 1 - Prevalence (%) of vaccine hesitancy among the different groups of health professionals.

Table 3 - Factors influencing Vaccine Hesitancy (VH) according to multivariate analysis

Feature	OR	p-value	[95% CI]
Age (years)[a]			
18-30	0.13	0.134	0.01-1.19
31-40	0.09	0.081	0.01-0.99
41-50	0.12	0.116	0.01-1.59
51-60	0.23	0.268	0.02-2.78
61-70	0.26	0.321	0.03-3.34
71-80	0.36	0.548	0.12-22.26
Previous COVID-19 infection[b]	0.94	0.869	0.42-2.07
Living with person aged >65 years[c]	2.10	0.001	1.33-3.31
Flu vaccination in the previous year[d]	0.22	<0.001	0.14-0.36
Adverse effects following past vaccinations[e]			
Yes			
Mild	0.61	0.190	0.30-1.27
Severe	3.33	0.020	1.51-11.88
No	0.23	<0.001	1.21-9.18

Comparison group for OR calculation: [a]subjects aged >80 years; [b]subjects with no previous COVID-19 infection; [c] subjects not living with people aged >65 years; [d]subjects not vaccinated against influenza in the previous year; [e]subjects with no intention of getting vaccinated

Health (Table 2; Figure 1). Additionally, multivariate analysis showed lower rates of VH in those health workers who had been vaccinated against influenza in the previous year, and in those who had never experienced adverse effects at previous vaccinations. On the contrary, subjects with family members older than 65, and who had experienced severe adverse effects at previous vaccinations, were more hesitant (Table 3).

Moreover, younger subjects were less hesitant than older ones (Supplementary Table 1).

Finally, comparing the different medical specialties, physicians working in geriatrics,

Supplementary Table 1 - Vaccine Hesitancy (VH) among different physicians by medical specialty.

Group	Not Hesitant N (%)	Hesitant N (%)	OR	p-value	[95% CI]
Allergology/Immunology	105 (98.1)	2 (1.9)	0.47	0.344	0.10-2.25
Anatomical Pathology	64 (98.5)	1 (1.5)	0.38	0.372	0.05-3.14
Anesthesiology	694 (99.0)	7 (1.0)	0.36	0.008	0.09-0.69
Audiology	10 (100.0)	0 (0.0)	1		
Cardiology	388 (99.0)	4 (1.0)	0.58	0.027	0.08-0.85
Community Outpatient Services	167 (98.2)	3 (1.8)	0.75	0.234	0.12-1.69
Dermatology	147 (99.3)	1 (0.7)	0.51	0.094	0.02-1.35
General Practice	1207 (98.5)	19 (1.6)	0.58	0.027	0.17-0.90
Genetics	25 (96.2)	1 (3.9)	0.99	0.989	0.12-8.21
Gastroenterology	150 (100.0)	0 (0.0)	1		
Geriatrics	265 (99.6)	1 (0.4)	0.19	0.026	0.01-0.75
Gynecology	444 (98.9)	5 (1.1)	0.28	0.026	0.09-0.86
Hematology	117 (99.2)	1 (0.9)	0.86	0.144	0.03-1.70
Endocrinology/Diabetes	271 (100.0)	0 (0.0)	1		
Hygiene/Public Health	163 (98.8)	2 (1.2)	0.30	0.133	0.06-1.44
Internal Medicine	398 (99.5)	2 (0.5)	0.31	0.009	0.03-0.59
Legal Medicine	79 (98.8)	1 (1.3)	0.31	0.276	0.04-2.53
Infectious Diseases	78 (100.0)	0 (0.0)	1		
Neurology	238 (99.6)	1 (0.4)	0.53	0.033	0.01-0.83
Nuclear Medicine	42 (97.7)	1 (2.3)	0.59	0.619	0.07-4.81
Occupational Medicine	127 (98.5)	2 (1.6)	0.59	0.236	0.08-1.86
Ophthalmology	144 (98.6)	2 (1.4)	0.34	0.179	0.07-1.63
Oncology	222 (99.6)	1 (0.5)	0.11	0.039	0.01-0.89
Urology	71 (100.0)	0 (0.0)	1		
Orthopedics	125 (99.2)	1 (0.8)	0.60	0.128	0.02-1.59
Palliative care	29 (96.7)	1 (3.3)	0.85	0.880	0.10-7.04
Pediatrics	934 (99.7)	3 (0.3)	0.19	<0.001	0.02-0.30
Sports Medicine	42 (100.0)	0 (0.0)	1		
Emergency Medicine	224 (100.0)	0 (0.0)	1		
Psychiatry/Psychology	404 (99.3)	3 (0.7)	0.24	0.013	0.05-0.70
Nephrology	156 (100.0)	0 (0.0)	1		
Pediatric Neuropsychiatry	106 (100.0)	0 (0.0)	1		
Otorhinolaryngology	120 (100.0)	0 (0.0)	1		
Pneumology	113 (100.0)	0 (0.0)	1		
Rheumatology	67 (98.5)	1 (1.5)	0.75	0.350	0.05-2.99
Radiology	458 (99.6)	2 (0.4)	0.27	0.005	0.02-0.51
Rehabilitation	159 (98.8)	2 (1.2)	0.47	0.142	0.06-1.48
Surgery	415 (98.8)	5 (1.2)	0.30	0.035	0.10-0.92
Clinical Biochemistry	7 (87.5)	1 (12.5)	3.52	0.265	0.39-32.11
Radiotherapy	87 (100.0)	0 (0.0)	1		
Clinical Pathology	50 (100.0)	0 (0.0)	1		
Clinical Microbiology	25 (100.0)	0 (0.0)	1		
Pharmacology	35 (97.2)	1 (2.8)	0.70	0.744	0.09-5.80
Unspecialized physicians	285 (97.3)	8 (2.7)	0.78	0.468	0.26-1.87

Supplementary Table 2 - Vaccine Hesitancy (VH) in the various age groups

Age (years)[a]	Not Hesitant N (%)	Hesitant N (%)	OR	p-value	[95% CI]
18-30	1,180 (99.0)	12 (1.0)	0.10	0.036	0.01-0.86
31-40	3,294 (99.5)	18 (0.5)	0.05	0.007	0.01-0.45
41-50	2,707 (99.0)	26 (1.0)	0.10	0.028	0.01-0.78
51-60	1,928 (98.3)	34 (1.7)	0.18	0.103	0.02-1.42
61-70	1,411 (98.1)	27 (1.9)	0.19	0.121	0.02-1.55
71-80	71 (94.7)	4 (5.3)	0.56	0.623	0.06-5.56

[a] OR calculated for the different age groups as compared to subjects aged >80 years

oncology and paediatrics were the most hesitant, while psychiatrists, neurologists, radiologists, anaesthesiologists, cardiologists, and surgeons were the most prone to be vaccinated (Supplementary Table 2).

Discussion and Conclusion

Vaccine hesitancy (VH) represents a major threat to the effectiveness of vaccination campaigns, especially in critical settings, where a fast and wide administration of vaccines is necessary, as for the current COVID-19 pandemic.

VH among healthcare professionals is even more detrimental for several reasons. First, they should be exposed to the lowest possible risk of infection and consequent disease manifestations, as they hold a fundamental role during pandemics. Second, once infected, they become a primary source of contagion due to the high number of daily contacts they have with people, most of whom are frail. Third, they should act as educators, whose opinion has rippling effects in influencing the general population.

Our study, in the attempt to contribute to a better understanding of this phenomenon, has shown a surprisingly low frequency of hesitant attitudes towards SARS-CoV-2 vaccination, if compared to the general population and other subpopulations (8). Even when compared to earlier studies assessing acceptance rates of vaccines against other pathogens among healthcare workers, our findings showed a considerably low rate of VH (13).This may be due to the heightened perception of the threat that COVID-19 poses to individuals and society when compared to other communicable diseases which lonely affect specific subpopulations, cause smaller outbreaks, and induce much less severe clinical outcomes. This applies even more so to healthcare professionals, who often are first-hand witnesses to the harrowing consequences of COVID-19.

Another factor that might come into play is the continuing absence of tangible alternatives to curb the spread of the COVID-19 pandemic (e.g. in the form of effective therapy), leaving only an effective vaccine as a unique way out of the current crisis.

An increased perception of risks associated with not being vaccinated, in this instance stemming from the abovementioned closeness to the effects of the disease, has been shown to be particularly effective in persuading to accept vaccination (14, 15). As for the possible causes of vaccine hesitancy among healthcare professionals, we have observed that having been vaccinated against the influenza virus in the past year reflected lower levels of VH, as did never having had important adverse effects following earlier vaccinations.

The first observation might imply that

trust in vaccines, where present, has not significantly been influenced by some of the most debated issues with existing and upcoming vaccines against SARS-CoV-2, such as concerns about the new viral m-RNA based vaccines and the comparatively short time period intercurred between the first stages of development and their distribution. Conversely, living with persons aged >65 years counterintuitively seems to increase the chance to be hesitant: this may be due to the confounding effect of some socio-economic conditions that are more frequently witnessed in families with one elderly person, and that are also associated with higher rates of VH. These include joblessness, lower average family income, being unable to save any money (16, 17). Nonetheless, our findings are unlikely to be able to be fully explaining in the light of this observation, and more research on the underlying causes of this behaviour might be needed.

Furthermore, among different healthcare professionals, physicians employed in paediatrics, oncology, and geriatrics seemed more prone to have an accepting attitude towards vaccines. This could be explained by the characteristics of the patients these professionals are more likely to come in contact with: in the case of paediatricians, children are more exposed than other age groups to infectious diseases in Western countries, which makes both their negative impact and the protective role of vaccines more apparent. As for oncologists and geriatrists, the frailty of their usual patient might sensitize these categories towards individual and collective protection respectively offered by vaccines and the associated herd immunity. If stratified in professional clusters, the less hesitant groups appeared to be those including professionals working in Primary Care and the Clinical Sciences/Public Health category. This might be due to the active involvement of primary care workers in the administration of vaccines to the general population in the Italian healthcare system, which can be expected to expose them to a steadier stream of reliable official information on vaccines nature and benefits. The Clinical Sciences/Public Health category includes professionals working in public health and preventive medicine who are more likely to be able to access and understand scientific evidence regarding vaccines and their development process, thereby leaving less space for conspiracy theories and lessening the impact of misinformation, which have proven to be among the main drivers of vaccine hesitancy (15, 18).

The main strengths of our study are the large sample of spontaneous participants, and the wideness of the array of different professionals recruited. A few limitations should be underlined as well. Our sample, although large, having been obtained from a specific group on a specific social network, is neither entirely representative of the Italian medical community nor - of course - of the Italian general population.

The potential self-selection caused by joining a group due to personal interest in topics debated, if summed with the possible differences between healthcare professionals who use social networks and those who do not, might have led us to underestimate VH in the population we aimed to study.

Furthermore, while possession of a license to practice medicine was assessed on admission to the group, a similar evaluation could not be put in place for non-physicians.

Finally, given the relatively long span of the observation period (more than one month), we might not have duly taken into account the volatility of public opinion regarding vaccines in these frantic times.

In conclusion, our study has the potential to help sparking a debate among Italian healthcare professionals, focusing their collective attention on possible strategies aimed at tackling VH. Even in the light of the relatively low registered VH rates, starting

such a debate is extremely important. Improving vaccine acceptance and information in this specific population can be doubly effective in the struggle against the ongoing pandemic, as they are employed at the frontlines and can be decisive in influencing the general population.

Finally, establishing possible targets for improvement of vaccine confidence can be a useful instrument in devising effective and rationally planned campaigns aimed at improving adherence.

Keypoints
Adherence to anti-COVI19 vaccine among our sample of healthcare professionals
Vaccine hesitancy among healthcare professionals
Determinants of vaccine hesitancy

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FG, BN, EM, MM were involved in each of the following points: 1. Data collection; 2. Manuscript writing; 3. Manuscript revision

Riassunto

Fiducia dei professionisti sanitari italiani nella vaccinazione contro covid-19 (anti-SARS-COV-2)

Background. La vaccinazione è uno degli strumenti più efficaci a disposizione della Salute Pubblica. La sua potenziale utilità è minacciata dalla crescente tendenza all'esitazione vaccinale a parte della popolazione generale, tanto da aver destato la preoccupazione dell'Organizzazione Mondiale della Salute (OMS). Il rischio rappresentato dall'esitazione vaccinale è ancora più concreto nel corso dell'attuale pandemia di COVID-19, il cui contenimento comporta l'istituzione di campagne vaccinali di massa. Questo vale in special modo per gli operatori sanitari, tra i quali l'esitazione ha effetti particolarmente dannosi per la comunità. Per questa ragione il nostro studio si focalizza su possibili determinanti di esitazione vaccinale tra gli operatori sanitari.

Disegno dello studio. Si tratta di uno studio trasversale.

Metodi. Lo studio è fondato sulla raccolta online di questionari autosomministrati in una coorte di operatori sanitari tra il 1 gennaio e il 16 febbraio 2021.

Risultati. Sono stati complessivamente analizzati 10 898 questionari. Di questi, l'1.1% mostrava esitazione vaccinale. Questa era meno frequente tra professionisti impiegati nelle Cure Primarie e nei Servizi/Salute Pubblica. Tra i clinici, risultavano particolarmente poco esitanti pediatri, oncologi e geriatri. Allo stresso modo, frequenze più basse si registravano tra i professionisti già vaccinati per influenza e quelli con nessuna storia di reazioni avverse gravi a seguito di vaccinazioni. Soggetti con famigliari di età > 65 anni e con storia di reazioni avverse gravi a vaccini precedenti mostravano livelli più alti di esitazione vaccinale.

Conclusione. L'esitazione vaccinale ha valori particolarmente bassi tra i professionisti sanitari coinvolti in questo studio. Alcune specifiche professioni, in particolar modo alcune specialità mediche, sembrano particolarmente ben disposte nei confronti della vaccinazione. I predittori e i fattori protettivi da noi individuati potrebbero consentire azioni mirate volte a contrastare l'esitazione vaccinale tra i professionisti sanitari.

References

1. Andre FE, Booy R, Bock HL, et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. Bull World Health Organ. 2008 Sep; **86**(2): 140-6. doi: 10.2471/blt.07.040089.
2. Callender D. Vaccine hesitancy: More than a movement. Hum Vaccines Immu-

nother. 2016 Sep; **12**(9): 2464-8. doi: 10.1080/21645515.2016.1178434. Epub 2016 May 9.
3. World Health Organization (WHO). Top ten threats to global health in 2019. Available on: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019 [Last accessed: 2021 Apr 4].
4. World Health Organization (WHO). Report of the SAGE working group on vaccine hesitancy. 2014. Available on: https://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf [Last accessed: 2021 Apr 4].
5. European Center for Disease Prevention and Control (ECDC). Vaccine hesitancy among healthcare workers and their patients in Europe. ECDC Technical Report. 2015. Available on: https://www.ecdc.europa.eu/en/publications-data/vaccine-hesitancy-among-healthcare-workers-and-their-patients-europe [Last accessed: 2021 Apr 4].
6. Britton T, Ball F, Trapman P. A mathematical model reveals the influence of population heterogeneity on herd immunity to SARS-CoV-2. Science. 2020 Aug; **369**(6505): 846-9. doi: 10.1126/science.abc6810. Epub 2020 Jun 23.
7. Billah MA, Miah MM, Khan MN. Reproductive number of coronavirus: A systematic review and meta-analysis based on global level evidence. PLoS One. 2020 Nov 11; **15**(11): e0242128. http://dx.doi.org/10.1371/journal.pone.0242128.
8. Sallam M. COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. Vaccines (Basel). 2021 Feb 16; **9**(2): 160. doi: 10.3390/vaccines9020160.
9. Barello S, Nania T, Dellafiore F, Graffigna G, Caruso R. "Vaccine hesitancy" among university students in Italy during the COVID-19 pandemic. Eur J Epidemiol. 2020 Aug; **35**(8):781-3. doi: 10.1007/s10654-020-00670-z. Epub 2020 Aug 6.
10. Nzaji MK, Ngombe LK, Mwamba GN, et al. Acceptability of Vaccination Against COVID-19 Among Healthcare Workers in the Democratic Republic of the Congo. Pragmat Obs Res. 2020 Oct; **29**(11): 103-9. doi: 10.2147/POR.S271096.
11. Grech V, Gauci C, Agius S. Vaccine hesitancy among Maltese healthcare workers toward influenza and novel COVID-19 vaccination. Early Hum Dev. 2020 Oct 1: 105213. https://doi.org/10.1016/j.earlhumdev.2020.105213.
12. Detoc M, Bruel S, Frappe P, Tardy B, Botelho-nevers E. Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic. Vaccine. 2020 Oct 21; **38**(45): 7002-6. doi: 10.1016/j.vaccine.2020.09.041. Epub 2020 Sep 17.
13. Costantino C, Ledda C, Squeri R, et al.E. Attitudes and Perception of Healthcare Workers Concerning Influenza Vaccination during the 2019/2020 Season: A Survey of Sicilian University Hospitals. Vaccines (Basel). 2020 Nov 16; **8**(4): 686. doi: 10.3390/vaccines8040686.
14. Lee MJ, Cho J. Promoting HPV Vaccination Online: Message Design and Media Choice. Health Promot Pract. 2017 Sep; **18**(5): 645-53. doi: 10.1177/1524839916688229. Epub 2017 Jan 27.
15. Puri N, Coomes EA, Haghbayan H, Gunaratne K. Social media and vaccine hesitancy : new updates for the era of COVID-19 and globalized infectious diseases. Hum Vaccin Immunother. 2020 Nov 1; **16**(11): 2586-93. doi: 10.1080/21645515.2020.1780846. Epub 2020 Jul 21.
16 ISTAT. Famiglie che non riescono a risparmiare o a far fronte a spese impreviste: numero di minori e anziani in famiglia. Indagine sulle condizioni di vita (EU-SILC). 2019. Available on: http://dati.istat.it/Index.aspx?QueryId=24680# [Last accessed 2021 Apr 4].
17. Malik AA, McFadden SAM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine. 2020 Sep; **26**: 100495. doi: 10.1016/j.eclinm.2020.100495. Epub 2020 Aug 12.
18. Verger P, Dubé E. Restoring confidence in vaccines in the COVID-19 era. Expert Rev Vaccines. 2020 Nov; **19**(11): 991-3. doi: 10.1080/14760584.2020.1825945. Epub 2020 Oct 8.

Corresponding Author: Davide Gori, MD PhD, Department of Biomedical and Neuromotor Sciences (DIBINEM), University of Bologna, Via San Giacomo 12, I-40126 Bologna, Italy
e-mail: davide.gori4@unibo.it