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What determines health professionals' COVID-19 vaccine hesitancy? A nationwide study

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Abstract

Introduction: To contain the COVID-19 pandemic, higher vaccination rates are essential. However, as vaccine hesitancy is a reality, it is important to understand what drives health professionals to refuse getting vaccinated against COVID-19, who have been in the frontline of this pandemic since its beginning and may be key actors to improve vaccine coverage among their patients.

Purpose: This study aims to assess the factors associated with vaccine hesitancy (VH) among health professionals (physicians, nurses, pharmacists and dentists).

Methods: A nationwide cross-sectional study was conducted through an online survey, with 890 Portuguese health professionals. A logistic regression analysis was used to determine the adjusted odds ratio (OR) of the independent variables (perceptions, knowledge and attitudes) per 1-point increase in the Likert scale and VH.

Results: Complacency, communications, confidence and convenience were strongly associated with VH probability. Concerns about vaccines' efficacy ($OR_{Physicians}$ = 8.33, 95% CI: 4.51–15.36) and safety (OR_{Nurses} = 11.07, 95% CI: 4.12–29.77) increase the risk of VH on all health professional groups. A reduction of VH probability is associated with higher risk perceptions of getting infected ($1/OR_{Nurses}$ = 2.76, 95% CI: 1.52–5.02) and suffering complications ($1/OR_{Nurses}$ = 33.72, 95% CI: 8.48–134.13), higher confidence in the effectiveness of COVID-19 vaccines ($1/OR_{Dentists}$ = 12.29, 95% CI: 2.91–51.89), risk perception of getting infected if vaccinated ($1/OR_{Physicians}$ = 14.92, 95% CI: 6.85–32.50), risk of suffering from complications after getting vaccinated, and higher trust levels on the information transmitted by competent authorities ($1/OR_{Dentists}$ = 17.76, 95% CI: 3.83–82.22).

Conclusions: To reduce COVID-19 VH, which appears to be highly influenced by perceptions, knowledge and attitudes, it is essential to promote interventions directed to transforming these potentially modifiable determinants.

KEYWORDS

COVID-19, cross-sectional, health professionals, hesitancy, Portugal, vaccination

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1 | BACKGROUND

With over 230 million cases and more than 4.8 million deaths by COVID-19 as of October 2021, and 3 million estimated excess deaths in 2020,[1] the COVID-19 pandemic has had a very significant impact worldwide.[2–4] Though most COVID-19 infections have shown to be asymptomatic or mild and self-limited[2,5]—which may have an impact on the decision to vaccinate against the disease[6]—mass vaccination campaigns are a key element to contain the spread of the pandemic. Vaccine hesitancy, being in 2019 considered one of the most significant health threats worldwide,[7] is defined as the unwillingness to be vaccinated, regardless of the availability of vaccines, being usually related to doubts and worries towards vaccine efficacy and safety.[7–10]

Despite the high efficacy of the vaccines approved for emergency use against COVID-19, their effectiveness is only observed when most of the population adheres to the vaccination process, thus being of utmost importance having low levels of vaccine hesitancy.[8] Vaccine hesitancy rates vary between countries.[4] Though there are models that explain different factors that influence vaccine hesitancy,[11] it is important to define which factors influence each of these dimensions and assess their magnitude.

Several studies have been conducted regarding the hesitancy of health professionals towards COVID-19 vaccination both during the months of the pandemic in which there were no vaccines approved and post-vaccines approval.[8,12–17] The reason for choosing this at-risk population was related to their role in combatting the COVID-19 pandemic and their priority in receiving the COVID-19 vaccine in Portugal, their risk for contracting the disease and their close contact with COVID-19 patients in a professional context. Furthermore, studying vaccine hesitancy in health professionals is important not only to understand what drives their hesitancy but also because they can highly influence the attitudes and behaviours of their patients towards vaccination.[18]

Hence, this study's objective consists of identifying the perceptions, beliefs and attitudes of the health professionals that determine vaccine hesitancy. This study may be crucial for the design of strategies to further improve COVID-19 vaccine acceptability among healthcare professionals and the general population.

2 | METHODS

2.1 | Setting

This study was carried out in mainland Portugal, which has a population of around 10.3 million inhabitants.[19] Mainland Portugal is divided into five main regions (NUTS-II), with the following population density: North (167.8 inhab/km^2), Centre (78.8 inhab/km^2), Lisbon Metropolitan Area (950.6 inhab/km^2), Alentejo (22.2 inhab/km^2) and Algarve (87.7 inhab/km^2).[19,20] Although there were significant changes in mortality from COVID-19 in Portugal throughout the pandemic, lethality rates after vaccination started have remained between 1.6% and 2%, reaching 4.3% before vaccination.[21] The COVID-19 vaccination plan was designed by a task force especially dedicated to planning the different vaccination phases and determining the priority groups.[22] As health professionals, namely hospital physicians and nurses, were those who contacted more closely with COVID-19 patients, they were included in the first phase of the vaccination process, thus being part of the kickstart of the vaccination process.[22] In terms of health professionals' workforce, there are 555.5 physicians, 757.7 nurses, 106.6 dentists and 151.2 pharmacists/100,000 inhabitants in Portugal.[23]

2.2 | Vaccination status

In Portugal, COVID-19 vaccination started on 27 December 2020 and, until the moment, four vaccines were approved for emergency use by the European Medicines Agency[24]: (i) Comirnaty® (Pfizer/BioNTech), (ii) Spikevax® (Moderna), (iii) Vaxzevria® (Oxford/AstraZeneca) and (iv) Janssen (Johnson & Johnson). From the beginning of the vaccination process, until the end of the distribution of this questionnaire, 32% of the population had received at least the first dose of the vaccine, and 14% had completed their COVID-19 vaccination plan.

2.3 | Study design and study population

This is a cross-sectional study, in which a questionnaire was distributed among the target population, between April 14th and May 16th, 2021, and involved different health professionals (nurses, physicians, pharmacists and dentists). We used the STROBE cross-sectional checklist when writing our report.[25]

2.3.1 | Questionnaire design

To design the questionnaire, a bibliographic review[26,27] and a qualitative study were first conducted. The focus group session with eight health professionals (three physicians, three nurses, one pharmacist and one dentist) was carried out to explore the main perceptions, and potential

behaviours regarding vaccination against SARS-CoV-2, compliance with Health General Directorate (DGS) recommendations and awareness on the pandemic impact. Due to the pandemic, the session was performed via videoconference, in December 2020. Considering the information obtained, the questionnaire was designed and content- and face-validated by a multidisciplinary panel (composed of epidemiologists, pharmacologists and public health experts). From this analysis, the panel provided suggestions to restructure two questions (S13 and S14) and to add the questions S17 and S18.

The questionnaire was divided into three different sections:

1. Sociodemographic characteristics of the participants (gender, age, geographical region, among others);
2. Evaluation of the overall health condition of the respondents, their vaccination status and if they suffer from chronic conditions;
3. Assessment of participants' perceptions, beliefs, attitudes and behaviours regarding the new vaccines against SARS-CoV-2. These variables were measured using a 4-point Likert scale (1-strongly disagree to 4-strongly agree).

2.3.2 | Questionnaire distribution

The population was invited to participate in the study, using a non-probabilistic snowball strategy. The questionnaire was applied online, with data collection being done through a paid campaign on social networks (Facebook; Instagram; LinkedIn), with a sponsored post containing a brief description, an image and a clickable URL to the questionnaire targeted to health professionals. In the digital campaign, 4 creativities (images) were created that were used interchangeably in the selected social networks. In each social network, the size/shape of the creative was adapted. The questionnaire was distributed by GAPS Politica I Societat Sl, a company dedicated to presenting, collecting and processing information. During this study, GAPS Politica I Societat Sl was responsible for creating and managing social media posts and collecting/aggregating the responses, providing then an anonymized spreadsheet to the research team. To ensure an appropriate sample size, survey panellists have also been invited to participate through the Cint™ platform by GAPS.

2.3.3 | Statistical analysis

The sample size calculation assumed an expected proportion of intention to be vaccinated of 66% (based on the flu vaccination coverage for these groups[28]) and a precision of 2%. A binary-dependent variable to assess VH was created based on three questionnaire items: (1) 'Have you already been vaccinated against COVID-19?'; (2) 'In case you haven't, why not?'; and 3) 'Once the COVID-19 vaccine is available for you, will you take it?'. This variable took the value '1' for those who were vaccine-hesitant and '0' for those who took the vaccine or were expecting to take it (Figure 1).

A binary logistic regression analysis was computed to model the associations between independent variables and the outcome—VH, stratifying the analysis per each health professional group: physicians, nurses, pharmacists and dentists. To this end, two sets of statistical models were created, namely: (i) the evaluation of personal sociodemographic and health condition variables, by using both crude and adjusted analyses; (ii) the assessment of the influence of the perceptions, beliefs, and attitudes displayed by the population under study and quantified in the survey, associated to both COVID-19 vaccination and vaccination intention, by adjusting for personal sociodemographic and health condition variables that showed $p < .1$ in the first model. Results were expressed as odds

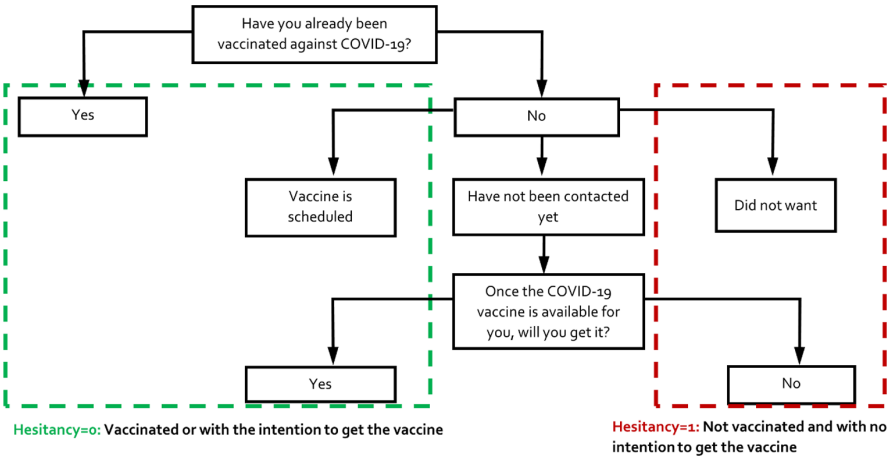

FIGURE 1 Vaccine hesitancy variable definition (created by the authors)

ratios (ORs) with their 95% confidence intervals (CIs), and correlated p-value (for which the level of statistical significance was set to $p < .05$).

2.3.4 | Ethics and data protection

The compliance with the provisions of the General Data Protection Regulation-Directive 95/46/EC (GDPR) was ensured, guaranteeing the security, anonymity and confidentiality of all data provided by the participants. Participation in the study was voluntary and participants provided their informed consent before participation. The focus group study obtained ethical approval from the Guarda Polytechnic Institute's Ethics Committee (01/2021). The data collection was conducted by GAPS Politics and Society SL, having as basis the contract established with 'la Caixa' Foundation, which is following the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of individuals concerning the processing of personal data and the free movement of such data, and which repeals Directive 95/46/EC (GDPR). In addition, the CEO of GAPS is a member of ESOMAR.

3 | RESULTS

In total, the campaign made more than 53.000 impacts (number of interactions from users (i.e. likes, comments, shares, saves), 520.000 impressions (number of times the content was displayed), and achieved 2.370 clicks on the published posts. Among those who have clicked, 1.350 have entered the survey and 567 have completed it. In parallel, a group of panellists has also been invited to participate. In total, 1.032 panellists (health professionals from mainland Portugal) were invited by e-mail to participate and 323 have completed the survey. In sum, a total of 890 complete surveys were obtained (Figure 2).

3.1 | Intention to get vaccinated

Table 1 shows the frequency and percentages of each health professional group regarding VH. Most health professionals either had already taken the vaccine or have the intention to do so, with percentages of vaccination intention surpassing 80% in every group. On the other hand, the physicians were the group with the highest percentage of VH, reaching 19% of the inquired physicians. Only 7.3% of the inquired pharmacists reported VH.

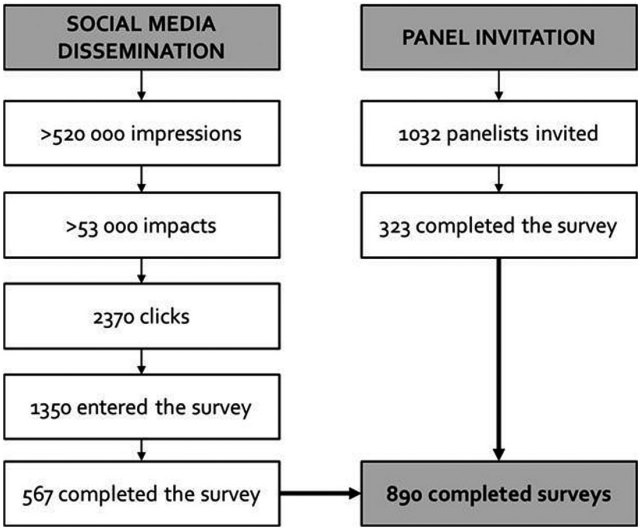

FIGURE 2 Health professionals' recruitment and survey completion (created by the authors)

TABLE 1 Vaccine hesitancy per health professional group (created by the authors)

	Not vaccinated and with no intention to get the vaccine—*N* (%)	Vaccinated or with the intention to get the vaccine—*N* (%)
Physicians	56 (19.0)	238 (81.0)
Nurses	28 (10.5)	239 (89.5)
Pharmacists	18 (7.3)	230 (92.7)
Dentists	11 (13.6)	70 (86.4)

3.2 | Influence of demographic characteristics on vaccination intention

Table 2 provides an analysis of the sociodemographic factors that influence VH per health professional group. Physicians from Algarve, Centre and Lisbon Metropolitan Area tend to be more unlikely to accept vaccination, presenting OR levels above 1. Female physicians are less likely to be hesitant by almost four-fold (1/OR = 3.34, 95% CI: 1.685–6.622, $p < .001$), and older physicians (aged 50–64 and 65–79) are more probable to be vaccine-hesitant against SARS-Cov-2 by over 4-fold (OR = 2.68, 95% CI: 1.100–6.548, $p = .03$ and OR = 5.73 95% CI: 1.005–32.725, $p = .049$). Those physicians who considered their health to be 'reasonable' were over seventeen times less prone to demonstrate VH (1/OR = 17.16, 95% CI: 1.689–174.282, $p = .016$). Similarly to Algarve physicians, nurses from the geographical area of Algarve (Southern area of Portugal) appear to be more prone to be hesitant towards vaccination by over thirteen-fold (OR = 13.75 95% CI: 2.350–80.760, $p = .004$). Both physicians and dentists from Lisbon

Metropolitan area are more prone to VH (OR = 3.11, 95% CI: 1.263–7.678, $p = .0014$ and OR = 25.32 95% CI: 1.802–355.692, $p = .017$, respectively), while pharmacists from Lisbon are almost five times less probable to refuse vaccination (1/OR = 4.80, 95% CI: 1.108–20.804, $p = .036$). On the other hand, dentists aged 35–49 tended to be over thirty-five times more likely to be vaccine-hesitant (OR = 35.14, 95% CI: 2.265–545.181, $p = .011$).

3.3 | Influence of perceptions, beliefs and attitudes on vaccine hesitancy

Table 3 provides the analysis of the influence of health professionals' perceptions, beliefs and attitudes on the intention to get vaccinated. Physicians who are particularly concerned about the risk of suffering from COVID-19 complications are less prone to be vaccine-hesitant (1/OR = 9.58, 95% CI: 5.02–18.29, $p < .01$ per 1-point Likert scale increase), along with those who feel less worried to get infected if vaccinated (1/OR = 5.74, 95% CI: 3.56–9.23, $p < .01$). Furthermore, physicians are less likely to exhibit VH with a 1-point Likert scale increase on the statement 'The probability of suffering complications from COVID-19 decreases with vaccination', and when considering that they must get vaccinated even after being infected with COVID-19 by almost 15- and 12-fold (1/OR = 14.92, 95% CI: 6.85–32.50, $p < .01$ and 1/OR = 12.10, 95% CI: 6.18–23.69, $p < .01$, respectively). The physicians who were mainly concerned with the vaccines' efficacy and safety were more likely to refuse vaccination (OR = 8.33, 95% CI: 4.51–15.36, $p < .01$ and OR = 5.26, 95% CI: 3.18–8.71, $p < .01$, respectively).

Similarly to physicians, nurses' agreement with the statements S1–S6 and S13–S18 (Table 3) is determinant to present lower levels of VH. Among these statements, those that have a higher influence are related to the seriousness of the COVID-19 disease, with an over 33-fold (1/OR = 33.72, 95% CI: 8.48–134.13, $p < .01$) probability of not refusing vaccination with a 1-point increase on the S3 statement. A 1-point Likert scale increase on the statement concerning the reliability of the information provided by the competent authorities has also a very high impact on VH (1/OR = 13.98, 95% CI: 5.90–33.10, $p < .01$). On the other hand, those who have more concordance with the statements S7–S12 were more prone to be vaccine-hesitant, being particularly concerned with the vaccines' efficacy and safety. The nurses that agreed with the statement 'I will only get the vaccine when the majority of the population has taken it' have also a higher probability to refuse vaccination.

Pharmacists were less likely to present vaccine-hesitant the more they agreed with sentences S2–S6, S14–S16 and S17 (see Table 3), presenting 1/OR values between 2.46 and 5.76 ($p < .01$). On the other hand, when pharmacists showed higher agreement levels on statements S7–S11, VH was more probable.

Dentists had also similar results to the other health professionals, though they were particularly less likely to be hesitant towards vaccination the more they agreed with the necessity of getting the vaccine after being infected (1/OR = 40.22, 95% CI: 5.99–269.91, $p < .01$), with the reduction of being infected/suffering complications from COVID-19 after being vaccinated (1/OR = 12.29, 95% CI: 2.91–51.89, $p < .01$ and 1/OR = 16.03, 95% CI: 3.33–77.14, $p < .01$, respectively), and with the reliability of the information released by competent authorities (1/OR = 17.76, 95% CI: 3.83–82.22, $p < .01$). By contrast, those who presented higher agreement levels with the statements S9–S12 were more prone to be vaccine-hesitant against COVID-19, especially those who were more concerned about the vaccines' manufacturer/country of origin. Contrarily to the other health professionals' groups, concerns about the vaccines' efficacy and safety were not significant determinants for vaccination acceptance/hesitancy.

4 | DISCUSSION

Health professionals play a key role in controlling the COVID-19 pandemic. However, contrarily to previously published literature,[16] the results of our study indicate that VH among health professionals is equal to or greater than in the general population,[29,30] with a high prevalence of VH of almost 20% among physicians, and around 10% in the other health professionals, which might be related to a higher number of concerns regarding these vaccines than other populations, such as older adults.[29] The results of our study indicate that VH is very strongly influenced by perceptions, beliefs and attitudes.[31] As these factors are modifiable, this study may support the development of communication and intervention strategies designed to change them, thus reducing VH.

4.1 | Demographic characteristics

In terms of demographic characteristics (context),[11] the results obtained were quite heterogeneous between health professional groups. Overall, gender was not a determinant of VH, though female physicians had almost four times less vaccine-hesitant. Regarding age, besides older physicians, who appear to be more reluctant to accept vaccination, only among younger dentists appears to exist a difference, as those between 35 and 49 years old are over thirty-five times more likely to refuse vaccination. However, these results may be overestimated,

TABLE 2 Characterization of the population under study and influence of their characteristics on the COVID-19 VH (created by the authors)

	Physicians ($n = 293$)			Nurses ($n = 265$)			Pharmacists ($n = 247$)			Dentists ($n = 80$)		
	COVID-19 vaccination intention *N* (%)		Adjusted analysis	COVID-19 vaccination intention *N* (%)		Adjusted analysis	COVID-19 vaccination intention *N* (%)		Adjusted analysis	COVID-19 vaccination intention *N* (%)		Adjusted analysis
	Yes	No	OR	Yes	No	OR	Yes	No	OR	Yes	No	OR
Gender												
Male	67 (68.4)	31 (31.6)	1	55 (88.7)	7 (11.3)	1	38 (95.0)	2 (5.0)	1	11 (78.5)	3 (21.4)	1
Female	169 (88.5)	22 (11.5)	0.30*	183 (90.6)	19 (9.4)	0.98	191 (93.2)	14 (6.8)	3.74	58 (87.9)	8 (12.1)	1.04
Rather not say	2 (50.0)	2 (50.0)	2.14	–	1 (100)	–	–	2 (100)	–	–	–	–
Age group (years)												
18–34	92 (88.5)	12 (11.5)	1	119 (91.5)	11 (8.5)	1	106 (94.6)	6 (5.4)	1	35 (94.6)	2 (5.4)	1
35–49	76 (78.4)	21 (21.6)	2.13	95 (87.2)	14 (12.8)	1.51	97 (90.7)	10 (9.3)	3.25	26 (76.5)	8 (23.5)	35.14*
50–64	63 (77.8)	18 (22.2)	2.68*	23 (92.0)	2 (8.0)	1.28	26 (96.3)	1 (3.7)	1.14	8 (88.9)	1 (11.1)	1.85
65–79	7 (63.6)	4 (36.4)	5.73*	1 (100)	–	–	–	1 (100)	–	–	–	–
Geographical area												
North	89 (90.8)	9 (9.2)	1	94 (94.0)	6 (6.0)	1	52 (88.1)	7 (11.9)	1	28 (90.3)	3 (9.7)	1
Centre	46 (78.0)	13 (22.0)	2.79*	54 (88.5)	7 (11.5)	2.11	63(94.0)	4 (6.0)	0.35	13 (92.9)	1 (7.1)	1.04
Lisbon Met. Area	79 (76.7)	24 (23.3)	3.11*	71 (91.0)	7 (9.0)	1.71	89 (96.7)	3 (3.3)	0.21*	24 (77.4)	7 (22.6)	25.32*
Alentejo	8 (80.0)	2 (20.0)	3.48	12 (85.7)	2 (14.3)	1.64	14 (93.3)	1 (6.7)	–	2 (100)	–	–
Algarve	10 (66.7)	5 (33.3)	4.72*	4 (57.1)	3 (42.9)	13.77*	9 (75.0)	3 (25.0)	2.23	1 (100)	–	–
Health status auto-evaluation												
Very good	88 (73.3)	32 (26.7)	1	49 (81.7)	11 (18.3)	1	75 (90.4)	8 (9.6)	1	30 (85.7)	5 (14.3)	1
Good	122 (84.7)	22 (15.3)	0.52	159 (90.9)	16 (9.1)	0.43	127 (95.5)	6 (4.5)	0.20*	31 (86.1)	5 (13.9)	1.70
Reasonable	27 (96.4)	1 (3.6)	0.06*	28 (96.6)	1 (3.4)	0.21	23 (85.2)	4 (14.8)	1.59	8 (88.9)	1 (11.1)	1.01
Weak/poor	–	1 (100)	–	3 (100)	–	<0.01	2 (100)	–	–	–	–	–
Very weak/very poor	1 (100)	–	–	–	–	–	3 (100)	–	–	1 (100)	–	–
Diagnosis of chronic disease												
No	166 (79.8)	42 (20.2)	1	170 (88.5)	22 (11.5)	1	171 (92.9)	13 (7.1)	1	53 (82.8)	11 (17.2)	1
Yes	72 (83.7)	14 (16.3)	0.82	69 (92.0)	6 (8.0)	0.74	59 (92.2)	5 (7.8)	1.23	17 (100)	–	–

*$p < .05$.

TABLE 3 Influence of the perceptions, beliefs and attitudes of health professionals on COVID-19 VH

	Physicians		Nurses		Pharmacists		Dentists	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
S1. The probability of getting COVID-19 is high	0.45	0.30–0.66	0.36	0.20–0.66	0.69	0.38–1.25	0.57	0.26–1.24
S2. I am concerned about the probability of getting COVID-19	0.24	0.15–0.39	0.13	0.06–0.28	0.34	0.18–0.64	0.19	0.07–0.52
S3. The complications from COVID-19 are serious	0.10	0.05–020	0.03	0.01–0.12	0.20	0.10–0.42	0.16	0.04–0.64
S4. The probability of being infected with COVID-19 decreases with vaccination	0.21	0.13–0.33	0.19	0.10–0.35	0.41	0.25–0.67	0.08	0.02–0.34
S5. I feel less worried about being infected with COVID-19 if I get vaccinated	0.17	0.11–0.28	0.24	0.13–0.43	0.39	0.23–0.67	0.17	0.06–0.52
S6. The probability of suffering complications from COVID-19 decreases with vaccination	0.07	0.03–0.15	0.15	0.07–0.30	0.19	0.09–0.40	0.06	0.01–0.30
S7. I am concerned about the vaccine's efficacy	8.33	4.51–15.36	4.15	2.13–8.09	3.57	1.77–7.19	–	–
S8. I am concerned about the vaccine's possible side effects	5.26	3.18–8.71	11.07	4.12–29.77	5.57	2.46–12.62	–	–
S9. I will only get the vaccine when the majority of the population has taken it	1.30	0.88–1.93	4.71	2.73–8.10	3.10	1.78–5.40	3.66	1.60–8.37
S10. I am concerned about the vaccine's manufacturer/country of origin	1.49	1.06–2.09	3.14	1.80–5.46	2.26	1.32–3.87	6.95	2.26–21.34
S11. I will only get the vaccine if it is required to travel between countries	1.04	0.70–1.53	2.95	1.83–4.76	2.75	1.65–4.57	2.08	1.07–4.07
S12. I will only get the vaccine if I obtain sufficient information	1.09	0.79––1.51	2.02	1.16–3.52	1.42	0.81–2.47	4.41	1.43–13.60
S13. COVID-19 vaccination: I believe that the information released on social media is reliable	0.15	0.08–0.28	0.20	0.10–0.40	0.57	0.28–1.15	0.14	0.04–0.46
S14. COVID-19 vaccination: I believe that the information released by the competent authorities is reliable	0.16	0.09–0.26	0.07	0.03–0.17	0.22	0.12–0.41	0.06	0.01–0.26
S15. I am confident that the pandemic will end when most of the population is vaccinated	0.14	0.08–0.24	0.26	0.14–0.51	0.31	0.15–0.64	0.16	0.05–0.54
S16. Even after being infected with COVID-19, I must get the vaccine	0.08	0.04–0.16	0.10	0.05–0.22	0.17	0.08–0.36	0.02	0.00–0.17
S17. If infected with COVID-19, I would like to take a test to check my acquired immunity	0.69	0.49–0.99	0.22	0.12–0.41	0.60	0.29–1.24	0.39	0.14–1.06
S18. After taking the COVID-19 vaccine, I would like to take a test to check my acquired immunity	0.50	0.35–0.71	0.28	0.16–0.49	0.31	0.17–0.60	0.26	0.09–0.69

Note: Adjusted odds ratio per 1-point in 4-point Likert scale of each perception, knowledge and attitude (created by the authors). ORs adjusted for sociodemographic characteristics ($p < .1$) – (i) physicians: gender, age, geographical area; (ii) nurses: geographical area; (iii) pharmacists: health status auto-evaluation; (iv) dentists: age. Click or tap here to enter text.

as eight out of the eleven dentists who had no intention to get vaccinated were from this age group; still, there is another study that obtained similar results among healthcare workers.[32]

When analysing differences between country regions, it appears that nurses and physicians from the region of Algarve are significantly more likely to refuse vaccination, which may be reflected in the lower vaccination rates in this region, when compared to others.[33] The regional hesitancy patterns may be caused by several factors such as different incidence and mortality rates by COVID-19[21] and local differentiation in deconfinement stages.[34,35]

Despite that there are no differences in VH among health professionals diagnosed with chronic diseases, only the physicians who consider their health status as 'reasonable' and pharmacists who perceived their health status as 'good' tend to be less likely to refuse vaccination when compared to those who considered their health to be 'very good', which may be explained by a higher tendency to be more protective of their health status. However, these results may be carefully considered, as they were only statistically significant for physicians and pharmacists, and the published literature has not found health status perception to be determinant for VH.[36]

4.2 | Perceptions, beliefs and attitudes towards COVID-19 vaccination

When analysing the perceptions, beliefs and attitudes towards COVID-19 vaccination, we observed that several factors influence health professionals' hesitancy to get vaccinated, being strongly associated with the Five C's (confidence, complacency, convenience, communications and context).[11] Complacency[11] appears to be one of the strongest factors for lower rates of VH: those who were more concerned about the risk of being infected and suffering from complications, as well as those who consider that being vaccinated decreases these risks, are less likely to decline vaccination, with a 1-point increase reducing VH up to almost 3300%. Furthermore, communications play a key role in VH: those who consider that the information provided by the competent authorities is trustworthy and those who agree that they have a responsibility of getting vaccinated are more likely to accept vaccination, reaching a 3900% decrease in VH per 1-point in the Likert scale, thus reinforcing the importance of collective responsibility to control the pandemic (communications).[11,37]

On the other hand, all health professionals who are particularly concerned with the vaccines' manufacturer and/or country of origin are more prone to be hesitant towards vaccination by ~1.5- to 7-fold, thus emphasizing the need to clarify the process of vaccines' approval and to improve transparency.[38]

Both nurses and physicians are less likely to be vaccine-hesitant if they believe they have a high probability of getting infected with COVID-19, reinforcing the idea that the risk perception of contracting COVID-19 is a significant determinant for vaccination acceptance.[12] Those who report being interested in testing for acquired immunity if getting infected are also less likely to be vaccine-hesitant, thus reflecting the perception that even after acquiring natural immunity, these health professionals prefer to be vaccinated, contrarily to those who give more importance to naturally-acquired immunity.[13]

Except for dentists, all health professionals who are more concerned about the safety and efficacy of the vaccine are more prone to decline vaccination against COVID-19, reaching a 1000% rise per 1-point increase in the Likert scale. Thus, confidence[11] constitutes one of the most widespread concerns regarding VH.[38–40]

When analysing the barriers to getting vaccinated (convenience),[11] it is observed that all health professionals who are more prone to VH, except for physicians, will only change their minds when most of the population has taken it or if it is required to travel. Moreover, nurses and dentists feel the need to get more information about the vaccine after taking it, highlighting the necessity of strengthening communication for health professionals even after vaccination.[38]

4.3 | Vaccination status in Portugal and vaccination intention

These results reveal that physicians were more prone to VH, diverging from previous literature.[17,41] Studies before vaccines' approval showed that nurses tended to be significantly more reluctant when compared to physicians.[8,12,42] These differences may be related to the fact that these studies report to a period before the implementation of widespread vaccination strategies, as nurses are currently the main professional group that administers the vaccines to the population. This may also be justified by the fact that nurses tend to work more closely with their patients when compared to physicians, thus feeling a higher necessity to feel protected against COVID-19 or to protect their patients.

In Portugal, besides governmental institutions, all Professional Official Colleges have been advising their respective health professionals to get vaccinated, which may have a significant impact in reducing vaccine hesitancy. Still, the period in which this survey was conducted was after the first vaccination phase, in which health professionals were among the priority groups.[22]

4.4 | Strengths and limitations

To our knowledge, this is the first study to identify the determinants associated with COVID-19 VH, while comparing different health professionals' groups. As this is a cross-sectional study, causal inferences cannot be drawn. As such, the generalization of results requires caution, demanding confirmation from other countries and contexts.

Though our sample may not be representative of all healthcare professionals in Portugal, the generalization of the results in the field of scientific research does not depend on the statistical representativeness of the study population, but on the mechanisms underlying the observed associations regarding the phenomenon under study.[43] It is possible that the health professionals participating in the study are more motivated and have better attitudes towards the subject of study than the total population. However, we believe that this is not an important limitation of our study, since the main objective of our study is not to determine the prevalence of vaccine hesitancy in health professionals in Portugal (which may be over- or under-estimated), but rather the influence of the perceptions, beliefs, attitudes about VH, which may not depend on the participation in the study.[43] In fact, according to Rothman,[43] the generalization of the results in the field of scientific research does not depend on the statistical representativeness of the study population, but on the mechanisms underlying the associations observed

concerning the phenomenon under study, which, in our case, are the influence of perceptions, beliefs and attitudes on VH. Furthermore, despite the statistical significance of the obtained ORs, some of the confidence intervals presented are wide, which might be due to a small proportion of vaccine-hesitant health professionals[44]. However, we believe this does not undermine the validity of our results.

5 | CONCLUSIONS

In conclusion, our study provides an overview of the main predictors of COVID-19 vaccine hesitancy among health professionals, with a special focus on the influence of perceptions, knowledge and attitudes. The results of our study may constitute an important contribution, as the main predictors for vaccine hesitancy are modifiable factors, namely regarding the perceptions on efficacy and safety of COVID-19 vaccination. Health professionals can play a key role in controlling the COVID-19 pandemic, mainly through their vaccination and counselling of their patients. However, the rejection of the vaccine by health professionals appears to be is equal to or greater to that of the general population. We feel that this study could provide a good basis for designing interventions aimed at decreasing VH and creating a culture of vaccination among health professionals.

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CONFLICTS OF INTEREST

None to declare.

AUTHOR CONTRIBUTIONS

All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by Marta Estrela, Tânia Magalhães Silva and Adolfo Figueiras. The first draft of the manuscript was written by Marta Estrela, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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