When the first vaccine arrived: An investigation of factors that influenced the intention of health care workers in the national health system of Greece to be vaccinated against the SARS COV-2 virus during the first trimester of vaccine arrival

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Abstract

Background: COVID-19 vaccination started in Greece in the last days of December 2020. Health care workers (HCWs) of the public national health system (NHS) were on the frontline and they would be role models for all the citizens.

Aim: Investigation of the intention and hesitation of HCWs (doctors, nurses, and nursing assistants) of the NHS of Greece, regarding the vaccine against SARS COV-2 virus and the factors that affect them, during the first trimester of the availability of vaccines, in the country.

Methods: A multicenter cross-sectional study was conducted in Greece among health professionals (n = 2484) of the NHS. Data were collected with the use of an online questionnaire through snowballing sampling.

Results: Acceptance of a safe and effective COVID-19 vaccines was higher among doctors (85.6%), followed by nurses (66.3%), and nursing assistants (64.1%). This study confirms pre-existing research on the interaction of gender, age, quality of personal information, educational level, training by the employer, and cognitive background regarding viruses and vaccines.

Conclusion: In conclusion, our study showed that once a vaccine was available, most HCWs were willing to be vaccinated. These findings could be used in the future to tailor communication and promotion campaigns, using anthropocentric strategies.

Keywords
COVID-19 vaccine, health care workers, vaccine hesitancy, vaccine intention

1 INTRODUCTION

Vaccination has historically proven effective and was one of the most useful public health achievements in the 20th century. As of January 2021, more than 290 candidate vaccines were introduced in preclinical and clinical phases using both classic and next-generation platforms against SARS COV-2. In Phase III trials, several vaccines show up to 95% efficacy in preventing symptomatic infections. The efficacy rate ranged from 62% to 96% for different COVID-19 vaccine products.
2 | BACKGROUND

The first emergency vaccination authorization from the Food and Drug Administration (FDA) was issued in December 2020 for two new types of vaccines, based on messenger RNA (mRNA) technology. These were the BNT162b2 formulations of the pharmaceutical companies Pfizer and BioNTech (December 11, 2020) and the mRNA-1273 of the pharmaceutical company Moderna (December 18, 2020). In addition, non-mRNA vaccines (ChAdOx1 nCoV-19/AstraZeneca, and Ad26.COV2.S/Janssen Pharmaceuticals) were licensed over the next 2 months. The European Medicines Agency and the European Commission have authorized Pfizer-BioNTech COVID-19 vaccine, Moderna COVID-19 vaccine, COVID-19 Vaccine AstraZeneca, and COVID-19 Vaccine Janssen in European countries. In Greece, the first doses of the BNT162b2 vaccine were given on December 27, 2020, and from the beginning to the middle of February, the vaccination with mRNA-1273 and ChAdOx1 nCoV-19 started. On May 5, 2021, the first Ad26.COV2.S vaccines were administered in the country.

The arrival of the first vaccines could not cover all the existing demand and for this reason, priority lists would have to be created. Based on the Strategic Advisory Group of Experts (SAGE) on Immunization values framework, WHO recommends vaccine priority for health care workers (HCWs), citizens with a serious underlying disease, and the elderly, and the government of Greece argued this through the guidance of the National Organization of Public Health. When it comes to HCWs, many ethics researchers confirm that they should have priority access to a vaccine in a flu pandemic, and this has happened in the current health crisis of COVID-19.

The rationale for prioritizing HCWs lies primarily in the fact that they play an important advisory role and serve as role models in vaccination programs, building trust. Their knowledge and attitudes regarding vaccination significantly affect citizens. They are also sources of nosocomial infections, which could have been avoided, and often act as superspreaders transmitting the infection to their already vulnerable groups of patients. In addition, they work in the frontline and are in high-risk locations. According to the European center for disease prevention and control, the proportion of HCWs among COVID-19 cases varied from 2.2% to 29% in countries with available data. A 1 year study among nine European countries found that the risk of HCWs being hospitalized and dying was 1.8 and 1.9 times higher than non-HCWs. Finally, infection, disease, and possible death of HCWs equal loss of critical resources of health systems, which are already at a critical juncture.

The experience from the past of influenza and H1N1 inherited several studies, which informed us about the reluctance of health professionals to be vaccinated. The SAGE Working Group on Vaccine Hesitancy, concluded that vaccine hesitancy refers to delay in acceptance or refusal of vaccination despite the availability of vaccination services and WHO proposed the “3C” model of vaccine hesitancy, which includes three aspects: confidence, convenience, and complacency. In 2019, Vaccine hesitancy has been considered by WHO as “one of the top ten threats to global health” causing serious problems in achieving coverage for population immunity, and the hypothesis that it would adversely affect HCWs’ vaccination, was obvious.

The purpose of this study was to record the trends of vaccination hesitancy against the SARS COV-2 virus among professional doctors, nurses, and nursing assistants of the national health system of Greece, during the first quarter of the availability of vaccines, in the country. In addition, an attempt is made to clarify the possible correlation of various factors that affect reluctance (socio-demographic factors, media about the pandemic, behavioral attitudes, beliefs, level of knowledge about the disease, and vaccination, etc.). We chose this time period, as we considered it important to record the first image at the arrival of the vaccines and because we assumed that the initial acceptance tendency would determine the continuation.

3 | METHODS

3.1 | Study design and population

A multicentre cross-sectional study was conducted in Greece among professional doctors, nurses, and nursing assistants. The study was conducted under the scientific supervision of the Nursing Department of Greece. Data were collected with the use of an online questionnaire which was administered to the participants via email (sent by relevant nurses’ associations and councils), newsletters, and social networks. A convenience snowballing sampling was utilized to recruit the participants. The inclusion criteria in this study were participants who were (1) professional doctors, nurses, or nursing assistants (2) working exclusively in the National Health System of the country in any health structure of primary, secondary, or tertiary health care, and (3) able to read and write in Greece. Exclusion criteria were self-employed, private HCWs, as well as unemployed health professionals of the above groups.

3.2 | Procedure

Data were collected through a pretested (in two hospitals among a separate group of 40 HCWs—not included in the study) for clarity, length, validity, and reliability. The results were used to improve the questionnaire. Specifically, the content validity of the instrument was designed based on the already existing relevant knowledge of the writing team, and all the questions were checked for content validity ratio (minimum content validity ratio: 0.85). The reliability of the internal consistency of the questionnaire was assessed by estimating the Cronbach’s α value (dichotomous questions) and the Kuder-Richardson’s value (Likert’s scale questions), with results >0.70, which was considered acceptable. The test–retest reliability was assessed over a period of 2 weeks and yielded a strong positive correlation between the responses. However, the research team has
reservations about the “memory effect” phenomenon, as the time period was relatively short. On the other hand, we could not increase the retest time, as the evolution of the pandemic may have affected the responses. The finalized survey instrument was adapted for administration via the Typeform online platform.

The questionnaire consisted of six sections. The first section contained information about sociodemographic characteristics, while the second 26 dichotomous questions with answers “yes” or “no,” present data on vulnerable groups, sources of information, and data on the disease, hospitalization, and death from COVID-19 of the participants. In the third section, there were six questions regarding participants’ beliefs about the risk, disease, hospitalization, and death from the virus in the future as well as the adoption of coronavirus conspiracy theories, while the fourth included 18 questions about beliefs about the COVID-19 vaccines, views on the vaccination intention, the type of vaccine, information on the vaccine, the obligation and the factors influencing the vaccination intention. Most questions in both sections were 10-point Likert (0 = not at all 10 = too much), except for two questions in Section 4, which were a 5-point Likert (0 = strongly disagree* to 5 = totally agree). The fifth section consisted of six questions about vaccination beliefs in general, views on vaccine hesitancy, influenza vaccination, and refusal to vaccinate themselves and the children of participants. The 10-point Likert-type questions were recorded for the purposes of the study as categorical variables of three classes (0–3 = not at all, 4–7 = moderate, and 8–10 = very much).

The last two sections were about COVID-19 disease (four questions) and SARS COV-2 vaccination (seven questions). All questions were “right,” “wrong,” and “I do not know,” except for two multiple choices. To assess the cognitive background, a scale was created based on the score of the correct answers to each question. The “I do not know” answers were considered wrong. The correct answers received a grade of 3 and the incorrect ones a score of 0. The range of scores was 0–9 for the cognitive background regarding the disease and 0–21 for the vaccination. A higher score also indicated a better cognitive background. For the specific analyses and for the knowledge regarding the disease, the score was used as a categorical variable of three classes based on the limits of the score 0–2 = lack of knowledge, 3–6 = moderate knowledge, and 7–9 = excellent knowledge, while respectively used and the knowledge rating for vaccination (0–9 = lack of knowledge, >9–15 = moderate knowledge, and >15–21 = excellent knowledge).

### 3.3 Statistical analysis

Categorical data of descriptive statistics are presented as numbers and percentages. $\chi^2$ goodness-of-fit test, or an asymptotic Likelihood ratio test, in the case where more than 20% of cells had less than five expected counts, was applied to determine the correlation between the dichotomous variable of intention to vaccination and other categorical variables of interest. Z-test was used to compare the proportions between the cells of two variables. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 24.0 (IBM Corp). The threshold for statistical significance was defined as $p < .05$.

### 3.4 Ethical considerations and human protection

This study, which is in line with the Helsinki Declaration (1964) and follows the guidelines of the European Network of Research Ethics Committees and the National Commission for Bioethics and Technoethics, was approved by the Committee on Research, Ethics, and Deontology (Reference Number: 36/14.01.2021) and consequently by the Scientific Council of the university hospital, where the first author works. Before completing the questionnaire, the participants were informed about the purposes of the study and provided informed consent, while they knew that their participation was voluntary. In addition, complete anonymity and noncollection of personal information (such as name, email, IP) were ensured.

### 4 RESULTS

#### 4.1 Basic demographics

The study was administered from January 1 to March 1, 2021. Of a total of 6786 respondents, 3645 completed the questionnaire (response rate 53.71%), and 1161 of them were excluded, as they did not meet the inclusion criteria. Population consisted of 2484 HCWs, who were doctors ($n = 785$, 31.6%), registered nurses ($n = 1699$, 55.4%), and nursing assistants ($n = 323$, 13.0%) who worked in the seven health districts of the country. Regarding their education level, 1269 (51.1%) were graduates of higher education, 709 (28.8%) holders of postgraduate degrees, and 181 (7.35%) holders of a doctoral degree. The largest percentage of participants ($n = 933$, 37.6%) were 40–49 years old, while the majority were women ($n = 1901$, 76.6%). Also, most of them (68.8%) were married or had entered into a cohabitation agreement, with children (64.3%) of which 927 (37.3%) had two children. All the sociodemographic characteristics are presented in Table 1–4.

The correlation of sociodemographic factors with the intention of the sample to be vaccinated showed a statistically significant difference depending on age ($\chi^2(4) = 49.43$, $p < .001$). Specifically, individuals belonging to the age group 40–49 (75.5%), 50–59 (79.35%), and ≥60 (80.6%) showed a higher rate of vaccination intention compared to that of individuals aged 30–39 (65.3%) and 20–29 (63%). In addition, a statistically significant correlation emerged between gender ($\chi^2(1) = 14.47$, $p < .001$), occupational group ($\chi^2(2) = 104.66$, $p < .001$) and education ($\chi^2(4) = 69.03$, $p < .001$). In particular, men (78.3%) had a higher rate of vaccination intention compared to women (70.2%), as well as doctors (85.6%) compared to
| Characteristics               | N (%)  |
|------------------------------|--------|
| **Age**                      |        |
| 20–29                        | 332 (13.4) |
| 30–39                        | 636 (25.6) |
| 40–49                        | 933 (37.6) |
| 50–59                        | 516 (20.8) |
| ≥60                          | 67 (2.7)  |
| **Gender**                   |        |
| Male                         | 581 (23.4) |
| Female                       | 1901 (76.6) |
| **Occupation**               |        |
| Physician                    | 785 (31.6) |
| Nursing staff                | 1699 (68.4) |
| Registered nurses            | 1376 (55.4) |
| Nursing assistants           | 323 (13.0) |
| **Education**                |        |
| Secondary                    | 325 (13.1) |
| Tertiary                     | 1269 (51.1) |
| Technological                | 715 (28.8) |
| University                   | 554 (22.3) |
| Postgraduate                 | 709 (28.5) |
| Doctorate                    | 181 (7.3)  |
| **Health regions**           |        |
| First                        | 554 (22.6) |
| Second                       | 266 (10.9) |
| Third                        | 343 (14.0) |
| Fourth                       | 303 (12.4) |
| Fifth                        | 202 (8.2)  |
| Sixth                        | 667 (27.2) |
| Seventh                      | 115 (4.7)  |
| **Health structure**         |        |
| Primary                      | 660 (26.6) |
| Secondary                    | 660 (26.6) |
| Tertiary                     | 1164 (46.9) |
| **Working in COVID-19 ward** |        |
| Yes                          | 1116 (46.7) |
| No                           | 1277 (53.4) |
| **Marital status**           |        |
| Single                       | 566 (22.80) |
| Married/cohabitation         | 1710 (68.80) |
| Agreement/coexist            |        |
| Widowed/divorced             | 208 (8.4)  |
| Characteristics          | N (%) |  
|--------------------------|-------|
| Parental status          |       |  
| Yes                      | 1598 (64.3) | |
| No                       | 886 (35.7)  | |
| Number of children       |       |  
| 1                        | 443 (17.8)  | |
| 2                        | 927 (37.3)  | |
| 3                        | 185 (7.4)   | |
| 4                        | 43 (1.7)    | |
| Vaccine intention        |       |  
| Total, N (%)             |        | |
| Willing, N (%)           |        | |
| Hesitant, N (%)          |        | |
| Statistical test         |        | |
| Age                      |       |  
| 20–29                    | 332 (13.4)  | |
| 30–39                    | 636 (25.6)  | |
| 40–49                    | 933 (37.6)  | |
| 50–59                    | 516 (20.8)  | |
| ≥60                      | 68 (2.7)    | |
| Total                    | 2844 (100)  | |
| Gender                   |       |  
| Male                     | 581 (23.4)  | |
| Female                   | 1901 (76.6) | |
| Total                    | 2482 (100.0) | |
| Occupation               |       |  
| Physician                | 785 (31.6)  | |
| Registered nurses         | 1376 (55.4) | |
| Nurse assist.            | 323 (13.0)  | |
| Total                    | 2484 (100.0) | |
| Education                |       |  
| Secondary                | 325 (13.1)  | |
| Technological            | 715 (28.8)  | |
| University               | 554 (22.3)  | |
| Postgraduate             | 709 (28.5)  | |
| Doctorate                | 181 (7.3)   | |
| Total                    | 2484 (100.0) | |
| Education of nursing staff|       |  
| Secondary                | 323 (19.0)  | |
| Technological            | 711 (41.8)  | |
| University               | 123 (7.2)   | |
| Postgraduate             | 510 (30.0)  | |
| Doctorate                | 32 (1.90)   | |
| Total                    | 1699 (100)  | |

(Continues)
nurses (66.3%) and nursing assistants (64.1%). Also, the higher level of education was associated with a higher intention to vaccinate, as the graduates of secondary education (63.7%) and technological education (63.9%) had lower percentages compared to the graduates of university education (80.3%), holders of a postgraduate degree (74.8%) and holders of a doctoral degree (84.0%). Finally, the relationship between the intention to vaccinate was not independent of the Health District in which the nurses worked \( \chi^2(6) = 19.93 \), 

### TABLE 1 (Continued)

| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
|-------------------|--------------|----------------|----------------|-----------------|
| **Education of physicians** | | | | |
| University        | 437 (55.7)   | 369 (84.4)a    | 68 (15.6)a     | \( \chi^2 = 2.10 \) |
| Postgraduate      | 199 (25.4)   | 170 (85.4)a    | 29 (14.6)a     | \( p = .349 \) |
| Doctorate         | 149 (19.0)   | 133 (89.3)a    | 16 (10.7)a     | \ | |
| Total             | 785 (100.0)  | 672 (85.6)     | 113 (14.4)     | |

Note: Different superscript letters symbolize subcategories of socio-demographic characteristics (columns) whose percentages differ statistically significantly, at the level of statistical significance \( \alpha < 0.05 \) (z-test comparison of percentages).

### TABLE 2 Vaccination intention of HCWs in relation to personal data related to COVID-19

| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
|-------------------|--------------|----------------|----------------|-----------------|
| **Number of tests** | | | | |
| 0–3               | 1043 (44.1)  | 758 (72.7)a    | 285 (27.3)a    | \( \chi^2 = 1.45 \) |
| 4–6               | 823 (34.8)   | 607 (73.8)a    | 216 (26.2)a    | \( p = .693 \) |
| 7–9               | 218 (9.2)    | 160 (73.4)a    | 58 (26.6)a     | \ | |
| ≥10               | 281 (11.9)   | 197 (70.1)a    | 84 (29.9)a     | \ | |
| Total             | 2365 (100.0)| 1722 (72.8)    | 643 (27.2)     | | |
| **Personal positive test history** | | | | |
| Yes               | 174 (7.0)    | 99 (56.9)a     | 75 (43.1)a     | \( \chi^2 = 21.50 \) |
| No                | 2310 (93.0)  | 1692 (73.2)b   | 618 (26.8)b    | \( p < .001 \) |
| Total             | 2484 (100.0)| 1791 (72.1)    | 693 (27.9)     | | |
| **Personal COVID-19 hospitalization history** | | | | |
| Yes               | 21 (0.8)     | 12 (57.1)a     | 9 (42.9)a      | \( \chi^2 = 2.35 \) |
| No                | 2463 (99.2)  | 1779 (72.2)a   | 684 (27.8)a    | \( p = .125 \) |
| Total             | 2484 (100.0)| 1791 (72.1)    | 693 (27.9)     | | |
| **Positive person in the family (or friend) in the past** | | | | |
| Yes               | 1353 (54.5)  | 1016 (75.1)a   | 337 (24.9)a    | \( \chi^2 = 13.21 \) |
| No                | 1131 (45.5)  | 775 (68.5)b    | 356 (31.5)b    | \( p < .001 \) |
| Total             | 2484 (100.0)| 1791 (72.1)    | 693 (27.9)     | | |
| **Death from COVID-19 in the family (or friend) in the past** | | | | |
| Yes               | 447 (18.0)   | 351 (78.5)a    | 96 (21.5)a     | \( \chi^2 = 11.17 \) |
| No                | 2037 (82.0)  | 1440 (70.7)b   | 597 (29.3)b    | \( p < .001 \) |
| Total             | 2484 (100.0)| 1791 (72.1)    | 693 (27.9)     | | |

Note: Different letters symbolize subcategories of sociodemographic characteristics (columns) whose percentages differ statistically significantly, at the level of statistical significance \( \alpha < .05 \) (z-test comparison of percentages).

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The working department ($\chi^2(1) = 23.09, p < .001$), as well as the parental status ($\chi^2(1) = 10.57, p = .008$), in all the participants. Corresponding results are recorded for those nurses who worked in COVID-19 departments (43.6%) compared to those who worked in non-COVID-19 (56.4%).

### 4.2 General and personal factors

Regarding the vulnerable groups of the sample ($n = 444, 17.9\%$ of the total), a statistically significant difference was found with respect to pregnant women ($\chi^2(1) = 26.72, p < .001$), who had a lower rate of

#### TABLE 3 Vaccination intention of HCWs in relation to personal data related to COVID-19

| Vaccine intention | Total, $N$ (%) | Willing, $N$ (%) | Hesitant, $N$ (%) | Statistical test |
|-------------------|----------------|-----------------|------------------|-----------------|
| Feeling of danger of the virus (all HCWs) | | | | |
| Yes | 2140 (86.2) | 1635 (76.4)$^a$ | 505 (23.6)$^a$ | $\chi^2 = 142.07$ $p < .001$ |
| No | 344 (13.8) | 156 (45.3)$^b$ | 188 (54.7)$^b$ | |
| Total | 2484 (100.0) | 1791 (72.1) | 693 (27.9) | |
| Feeling of danger of the virus (physicians) | | | | |
| Yes | 681 (86.8) | 605 (88.8)$^a$ | 76 (11.2)$^a$ | $\chi^2 = 43.65$ $p < .001$ |
| No | 104 (13.2) | 67 (64.4)$^b$ | 37 (35.6)$^b$ | |
| Total | 785 (100.0) | 672 (85.6) | 113 (14.4) | |
| Feeling of danger of the virus (registered nurses) | | | | |
| Yes | 1169 (85.0) | 831 (71.1)$^a$ | 338 (28.9)$^a$ | $\chi^2 = 80.35$ $p < .001$ |
| No | 207 (15.0) | 81 (39.1)$^b$ | 126 (60.9)$^b$ | |
| Total | 1376 (100.0) | 912 (66.3) | 464 (33.7) | |
| Feeling of danger of the virus (nursing assistants) | | | | |
| Yes | 290 (89.8) | 199 (68.6)$^a$ | 91 (31.4)$^a$ | $\chi^2 = 25.35$ $p < .001$ |
| No | 33 (10.2) | 8 (24.2)$^b$ | 25 (75.8)$^b$ | |
| Total | 323 (100.0) | 207 (64.1) | 116 (35.9) | |

**Abbreviation:** HCWs, health care workers.

**Note:** Different letters symbolize subcategories of personal data (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ (z-test comparison of percentages).

#### TABLE 4 Attitudes of HCWs about the SARS COV-2 virus and its influence in a family member in the future

| Vaccine intention | Total, $N$ (%) | Willing, $N$ (%) | Hesitant, $N$ (%) | Statistical test |
|-------------------|----------------|-----------------|------------------|-----------------|
| Possibility of future infection of a family member | | | | |
| Not at all/little | 186 (7.5) | 117 (62.9)$^a$ | 69 (37.1)$^a$ | $\chi^2 = 14.92$ $p < .001$ |
| Enough | 1544 (62.6) | 1103 (71.4)$^b$ | 441 (28.6)$^b$ | |
| Very | 737 (29.9) | 563 (76.4)$^c$ | 174 (23.6)$^c$ | |
| Total | 2467 (100.0) | 1783 (72.3) | 684 (27.7) | |
| Possibility of future death of a family member | | | | |
| Not at all/little | 542 (22.9) | 348 (64.2)$^a$ | 194 (35.8)$^a$ | $\chi^2 = 32.12$ $p < .001$ |
| Enough | 1471 (62.1) | 1082 (73.6)$^b$ | 389 (26.4)$^b$ | |
| Very | 356 (15.0) | 288 (80.9)$^c$ | 68 (19.1)$^c$ | |
| Total | 2369 (100.0) | 1718 (72.5) | 651 (27.5) | |

**Note:** Different letters symbolize subcategories of the sense of danger of the virus (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ (z-test comparison of percentages).
vaccination intention (25.0%) compared to those who were not pregnant (72.6%). Physicians and registered nurses who had been diagnosed with coronavirus in the past had a statistically significantly lower rate of vaccination intention ($\chi^2(1) = 11.48$, $p < .001$) and ($\chi^2(1) = 11.60$, $p < .001$), respectively. The reverse was true for both health professionals who previously had a COVID-19 positive family member ($\chi^2(1) = 13.21$, $p < .001$), as well as for physicians and registered nurses who had experienced a death from COVID-19, in their families ($\chi^2(1) = 7.38$, $p = .007$), respectively. Finally, nursing assistants who had performed >10 diagnostic tests for the virus, intend to be vaccinated at a higher rate than the other health professionals ($\chi^2(1) = 7.98$, $p = .046$) (Table 2).

### 4.3 Attitudes and beliefs

HCWs who consider the virus to be dangerous, and those who consider it very likely to get coronavirus ($\chi^2(2) = 14.92$, $p < .001$) or to have a family member die in the future ($\chi^2(2) = 32.12$, $p < .001$), show higher rates of vaccination intention (Tables 2-5). Doctors ($\chi^2(2) = 32.32$, $p < .001$), nurses ($\chi^2(2) = 75.29$, $p < .001$), and nursing assistants ($\chi^2 = 9.89$, $p = .007$), who embrace conspiracy theories to a great extent, evoke increased hesitation (Table 6). Regarding the vaccine they would choose against the coronavirus, HCWs who would choose a type of mRNA vaccine has a statistically significantly greater intention to be vaccinated ($\chi^2(2) = 299.62$, $p < .001$), as well as health professionals who consider that the vaccine against the new coronavirus should be mandatory for health professionals ($\chi^2(1) = 292.10$, $p < .001$) (Table 7).

| Table 5 | The role of conspiracy theories |
|---------|-------------------------------|
| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
| Question: How much do you embrace conspiracy theories about the new coronavirus? |
| All HCWs | Not at all/little | 2134 (85.9) | 1626 (76.2)$^a$ | 508 (23.80)$^a$ | $\chi^2 = 143.80$ $p < .001$ |
| | Moderate | 277 (11.0) | 142 (52.2)$^b$ | 130 (47.8)$^b$ |
| | Very | 77 (3.1) | 22 (28.6)$^b$ | 55 (71.4)$^c$ |
| | Total | 2483 (100.0) | 1790 (72.1) | 693 (27.9) |
| Physicians | Not at all/little | 735 (93.6) | 642 (87.3)$^a$ | 93 (12.7)$^a$ | $\chi^2 = 32.32$ $p < .001$ |
| | Moderate | 42 (5.4) | 27 (64.3)$^b$ | 15 (35.7)$^b$ |
| | Very | 8 (1.0) | 3 (37.5)$^b$ | 5 (62.5)$^b$ |
| | Total | 785 (100.0) | 672 (85.60) | 113 (14.4) |
| Registered nurses | Not at all/little | 1148 (83.5) | 812 (70.70)$^a$ | 336 (29.3)$^a$ | $\chi^2 = 75.29$ $p < .001$ |
| | Moderate | 172 (12.5) | 86 (50.0)$^b$ | 86 (50.0)$^b$ |
| | Very | 55 (4.0) | 13 (23.60)$^b$ | 42 (76.4)$^b$ |
| | Total | 1375 (100.0) | 911 (66.3) | 464 (33.7) |
| Nursing assistants | Not at all/little | 251 (77.7) | 172 (68.5)$^a$ | 79 (31.5)$^a$ | $\chi^2 = 9.89$ $p = .007$ |
| | Moderate | 58 (18.0) | 29 (50.0)$^b$ | 29 (50.0)$^b$ |
| | Very | 14 (4.3) | 6 (42.9)$^a,b$ | 8 (57.10)$^a,b$ |
| | Total | 323 (100.0) | 207 (64.1) | 116 (35.9) |

Abbreviation: HCWs, health care workers.

Note: Different letters symbolize subcategories of COVID-19 disease beliefs (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ (z-test percentage comparison).
strongly influenced by their religious beliefs show less intention to be vaccinated ($\chi^2(2) = 26.35, p < .001$) (Table 7).

### 4.4 Knowledge about SARS COV-2 virus and COVID-19 vaccination

HCWs of the National Health Service inform about COVID-19 in a larger percentage (62.8%) from scientific articles and follow as sources of information the instructions of the National Public Health Organization (54.6%) and the internet (49.3%). The smallest percentage as a source of information corresponds to the newspapers (6.2%). Those who were informed by social media and television programs had the lower vaccination intention, while those who chose information from WHO, had the highest. Regarding the degree of information about SARS COV-2 vaccination from the organization where HCWs worked, those who considered themselves to be moderately and very well informed were more likely to be vaccinated than those who were not feeling that they were adequately informed ($\chi^2(2) = 88.84, p < .001$). In terms of the knowledge background about the virus, doctors gather the largest percentage of sufficient knowledge ($n = 316, 40.3%$), followed by nurses ($n = 326, 33.4%$) and nursing assistants ($n = 50, 15.5%$). Corresponding results are obtained for the cognitive background for the coronavirus vaccine, with the doctors having the highest percentage of sufficient knowledge ($n = 414, 52.7%$) followed by the nurses ($n = 277, 48.8%$) and nursing assistants ($n = 43, 13.3%$). Also, HCWs who were university graduates showed a higher level of adequate knowledge about COVID-19 disease ($\chi^2 = 77.89, p < .001$), while PhD holders had a higher rate of vaccination ($\chi^2(2) = 283, 95, p < .001$). Physicians with adequate knowledge of COVID-19 disease intend to be vaccinated at a higher rate ($\chi^2(2) = 10.91, p < .005$), while in terms to the SARS COV-2 vaccine cognitive background, doctors ($\chi^2(2) = 13.52, p < .002$), nurses ($\chi^2(2) = 55.09, p < .001$) and nursing assistants ($\chi^2(2) = 13.30, p < .001$), who have sufficient knowledge show lower rates of hesitancy (Tables 8–10).
| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
|-------------------|-------------|---------------|----------------|-----------------|
| Vaccine effectiveness |             |               |                |                 |
| Not at all/little | 329 (13.2)  | 102 (31.0)a   | 227 (69.0)a    | $\chi^2 = 471.74$ |
| Moderate          | 1055 (42.5)| 698 (66.2)b   | 357 (33.8)b    | $p < .001$      |
| Very              | 1100 (44.3)| 991 (90.1)c   | 109 (9.9)c     |                 |
| Total             | 2484 (100.0)| 1791 (72.1)   | 693 (27.9)     |                 |
| Vaccine safety    |             |               |                |                 |
| Not at all/little | 480 (19.3)  | 298 (62.1)a   | 182 (37.9)a    | $\chi^2 = 39.35$ |
| Moderate          | 1077 (43.4)| 771 (71.6)b   | 306 (28.4)b    | $p < .001$      |
| Very              | 926 (37.3)  | 721 (77.9)c   | 205 (22.1)c    |                 |
| Total             | 2483 (100.0)| 1790 (72.1)   | 693 (27.9)     |                 |
| Increasing number of infected |             |               |                |                 |
| Not at all/little | 336 (13.5)  | 98 (29.2)a    | 238 (70.8)a    | $\chi^2 = 501.96$ |
| Moderate          | 1018 (41.0)| 677 (66.5)b   | 341 (33.5)b    | $p < .001$      |
| Very              | 1130 (45.5)| 1016 (89.9)c  | 114 (10.1)c    |                 |
| Total             | 2484 (100.0)| 1790 (72.1)   | 693 (27.9)     |                 |
| Increasing number of deaths | | | | |
| Not at all/little | 380 (15.3)  | 129 (33.9)a   | 251 (66.1)a    | $\chi^2 = 457.45$ |
| Moderate          | 1040 (41.9)| 703 (67.6)b   | 337 (32.4)b    | $p < .001$      |
| Very              | 1064 (42.8)| 959 (90.1)c   | 105 (15.2)c    |                 |
| Total             | 2484 (100.0)| 1791 (72.1)   | 693 (27.9)     |                 |
| Duration of vaccine protection | | | | |
| Not at all/little | 550 (22.2)  | 294 (53.5)a   | 256 (46.5)a    | $\chi^2 = 127.39$ |
| Moderate          | 1261 (50.8)| 954 (75.7)b   | 307 (24.3)b    | $p < .001$      |
| Very              | 672 (27.1)  | 542 (80.7)c   | 130 (19.3)c    |                 |
| Total             | 2483 (100.0)| 1790 (72.1)   | 693 (27.9)     |                 |
| Encouragement from the family | | | | |
| Not at all/little | 1308 (52.7)| 896 (68.5)a   | 412 (31.5)a    | $\chi^2 = 32.06$ |
| Enough            | 892 (35.9)  | 654 (73.3)b   | 238 (26.7)b    | $p < .001$      |
| Very              | 284 (11.4)  | 241 (84.9)c   | 43 (15.1)c     |                 |
| Total             | 2484 (100.0)| 1791 (72.1)   | 693 (27.9)     |                 |
| Degree of influence from religious beliefs | | | | |
| Not at all/little | 418 (65.3)  | 289 (69.1)a   | 129 (30.9)a    | $\chi^2 = 26.35$ |
| Enough            | 166 (25.9)  | 83 (50.0)b    | 83 (50.0)b     | $p < .001$      |
| Very              | 56 (8.8)    | 25 (44.6)b    | 31 (55.4)b     |                 |
| Total             | 640 (100.0) | 397 (62.0)    | 243 (38.0)     |                 |

Note: Different letters symbolize subcategories of vaccination obligation (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ ($\chi^2$ test percentage comparison).
5 | DISCUSSION

During our study, a vaccine against the SARS COV-2 virus was available in Greece and HCWs were among those that would be given priority. According to our findings, 72.1% were willing to receive a safe and effective vaccine, which is very close to the reported vaccine coverage of HCWs in Greece (72.6%) at the end of May 2021.31 Also, at the time of our study was completed, a scoping review of 35 studies globally reported an average rate hesitancy of 22.51%,32 that is, 7% lower compared to our study.
Vaccination hesitation can be triggered by various factors. This study confirms pre-existing research on the interaction of gender, age, quality of personal information, educational level, training by the employer, and cognitive background regarding viruses and vaccines. Also, parenting, family history of illness or death, as well as the adoption of conspiracy theories and religious beliefs, proved to be critical factors in our study. Below, we will seek to negotiate some of the above factors.

### 5.1 The influence of demographic characteristics

The study showed that men are more willing to be vaccinated than women. This is completely in line with the results of a number of previous studies in Greece, Hong Kong, Israel, France, Congo, USA, Spain, and Italy. A study in five European countries (three European Union—Greece, Spain, Cyprus, and two non EU Albania and Kosovo, report that women HCWs show higher rates of vaccination hesitation. This female reluctance has also been reported in a 2017 review of tetanus, diphtheria, pertussis, and influenza vaccinations. The increased chance of serious illness or even death due to COVID-19, which is observed in men, and the unfounded rumors about vaccines having detrimental effects on fertility, pregnancy, and breastfeeding, are probably interpretive factors. All of the above advocate the development of a targeted strategy aimed at increasing the percentage of vaccinated women.

An additional demographic factor influencing vaccination intention was age. Older HCWs were more likely to be vaccinated, and this finding is confirmed by several studies. However, we believe that the explanation is quite related to the increased risk of age-related infection and the fact that the elderly are associated with higher rates of serious illness and mortality compared to the young.

In addition, our study showed a positive correlation between parenthood and vaccination intention, a finding that is in line with other studies. The sense of a parent’s uniqueness in raising their children, and the potential fear of hospitalization and/or death, as well as their impact on children, are possible reasons.

### Table 9 Correlation of knowledge background about COVID-19 and intention to be vaccinated

| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
|-------------------|--------------|----------------|----------------|-----------------|
| **COVID-19 knowledge background (All HCWs)** | | | | |
| Incomplete | 54 (2.2) | 33 (61.1)a | 21 (38.9)a | $\chi^2 = 21.89$ $p < .001$ |
| Moderate | 1733 (69.9) | 1212 (69.9)a | 521 (30.1)a |
| Adequate | 692 (27.9) | 544 (78.6)b | 148 (21.4)b |
| Total | 2479 (100.0) | 1789 (72.2) | 690 (27.8) |
| **COVID-19 knowledge background (physicians)** | | | | |
| Incomplete | 11 (1.4) | 6 (54.5)a | 5 (45.5)a | $\chi^2 = 10.91$ $p < .005$ |
| Moderate | 458 (58.3) | 387 (84.5)b | 71 (15.5)b |
| Adequate | 316 (40.3) | 279 (88.3)b | 37 (11.7)b |
| Total | 785 (100.0) | 672 (85.6) | 113 (14.4) |
| **COVID-19 knowledge background (registered nurses)** | | | | |
| Incomplete | 33 (2.4) | 23 (69.7)a | 10 (30.3)a | $\chi^2 = 4.28$ $p = .116$ |
| Moderate | 1013 (73.8) | 656 (64.8)a | 357 (35.2)a |
| Adequate | 326 (23.8) | 231 (70.9)a | 95 (29.1)a |
| Total | 1372 (100.0) | 910 (66.3) | 462 (33.7) |
| **COVID-19 knowledge background (nursing assist.)** | | | | |
| Incomplete | 10 (3.1) | 4 (40.0)a | 6 (60.0)a | $\chi^2 = 2.87$ $p = .259$ |
| Moderate | 262 (81.4) | 169 (64.5)a | 93 (35.5)a |
| Adequate | 50 (15.5) | 34 (68.0)a | 16 (32.0)a |
| Total | 322 (100.0) | 207 (64.3) | 115 (35.7) |

Note: Different letters symbolize subcategories of information sources (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ (z-test comparison of percentages).
there are some reasons for this phenomenon, as our study showed that doctors have a higher awareness of the risk of the virus and a more adequate cognitive background compared to the nursing staff, which more often adopts conspiracy theories and consists mainly of women. Finally, our study proves and confirms the existing data from other studies\textsuperscript{33,36,37,40,43} that a higher level of education favors a greater intention to vaccinate. Studies found that HCWs' confidence in the safety and benefit of vaccines was related to their educational level.\textsuperscript{60,61} Holders of PhD and postgraduate degrees and university graduates show lower rates of hesitancy compared to graduates of technology or secondary schools.

5.2 The influence of vulnerability

There are studies that confirmed high rates of intention in HCWs with chronic diseases,\textsuperscript{35,39,45,62} but our study confirms a strong positive effect in participants with underlying heart disease (82.7\%) or oncolgical history (79.7\%). The other vulnerable groups of participants did not differ significantly compared to the healthy ones. At the same time, pregnant women had the lowest intention rates (25\%). We consider the initial reluctance of pregnant women to be completely normal, because WHO, in the context of the initial prioritization plan for the distribution of vaccines, excluded pregnant women and children.

Also, HCWs who had been infected with the coronavirus in the past had a statistically significantly lower rate of vaccination intention than their noninfected colleagues. A study from Spain,\textsuperscript{44} is in line with this.

5.3 The influence of attitudes and beliefs

Our multicenter study seals the clear and decisive role that other similar studies\textsuperscript{36,44,63,64} have shown in the fact that there is a strong negative impact of historical seasonal vaccination for influenza, as well as HCWs who report a history of hesitation and have postponed and/or refused in the past one of the general vaccines.

Another fact that highlights the impact of beliefs is the increased intention to vaccinate those who consider the virus dangerous, as well as those who feel very likely in the future to

| TABLE 10 Correlation of knowledge background about COVID-19 vaccines and intention to be vaccinated |
|---|---|---|---|
| Vaccine intention | Total, N (%) | Willing, N (%) | Hesitant, N (%) | Statistical test |
| Vaccines knowledge background (all HCWs) | | | | |
| Incomplete | 425 (17.1) | 226 (53.2)\textsuperscript{a} | 199 (46.8)\textsuperscript{a} | $\chi^2 = 146.03$ $p < .001$ |
| Moderate | 1322 (53.3) | 932 (70.5)\textsuperscript{b} | 390 (29.5)\textsuperscript{b} | |
| Adequate | 734 (29.6) | 630 (85.8)\textsuperscript{c} | 104 (14.2)\textsuperscript{c} | |
| Total | 248 (100.0) | 1788 (72.1) | 693 (27.9) | |
| Vaccines knowledge background (physicians) | | | | |
| Incomplete | 28 (3.6) | 19 (67.9)\textsuperscript{a} | 9 (32.1)\textsuperscript{a} | $\chi^2 = 13.52$ $p = .002$ |
| Moderate | 343 (43.7) | 284 (82.8)\textsuperscript{a} | 59 (17.2)\textsuperscript{a} | |
| Adequate | 414 (52.7) | 369 (89.1)\textsuperscript{b} | 45 (10.9)\textsuperscript{b} | |
| Total | 785 (100.0) | 672 (85.6) | 113 (14.4) | |
| Vaccine's knowledge background (Registered Nurses) | | | | |
| Incomplete | 798 (58.1) | 525 (65.8)\textsuperscript{b} | 273 (34.2)\textsuperscript{b} | $\chi^2 = 55.09$ $p < .001$ |
| Moderate | 277 (20.2) | 227 (81.9)\textsuperscript{c} | 50 (18.1)\textsuperscript{c} | |
| Adequate | 1373 (100.0) | 909 (66.2) | 464 (33.8) | |
| Total | | | | |
| Vaccine's knowledge background (nursing assist.) | | | | |
| Incomplete | 99 (30.7) | 50 (50.5)\textsuperscript{a} | 49 (49.5)\textsuperscript{a} | $\chi^2 = 13.30$ $p = .001$ |
| Moderate | 181 (56.0) | 123 (68.0)\textsuperscript{b} | 58 (32.0)\textsuperscript{b} | |
| Adequate | 43 (13.3) | 34 (79.1)\textsuperscript{b} | 9 (20.9)\textsuperscript{b} | |
| Total | 323 (100.0) | 207 (64.1) | 116 (35.9) | |

Note: Different letters symbolize the subcategories of the cognitive background for COVID-19 (columns) whose percentages differ statistically significantly, at the level of statistical significance $\alpha = .05$ (z-test percentage comparison).
become infected and/or die a member of their family, due to the SARS COV-2 virus. In addition, HCWs who say they are encouraged to be vaccinated, to a large extent by family and friends, as well as those who agree on the obligation to HCWs, show low levels of vaccination hesitation. There are already published studies that have shown the correlation between conspiracy theories and the effect of religious beliefs on vaccination reluctance. Our study proves the above correlation.

5.4 The influence of knowledge

A final subject of discussion, which emerged from our study and we cite, is the HCWs’ cognitive background on the virus and its vaccination and its positive effect on the willingness to vaccinate. Although there was a difference in the level of knowledge of the three occupational categories, with physicians having the highest rates and nursing assistants having the lowest, all participants with adequate knowledge of both virus and vaccination subjects, were shown to have the intention to get vaccinated at a higher rate, which has been confirmed by other studies.

6 LIMITATIONS AND STRENGTHS

A major limitation of our study is that it was a cross-sectional one and used a convenience sampling method with snowballing samples method. The above limits the generalization of conclusions for all HCWs in the country. Moreover, at the time of the study, the only vaccines which were available for the country, were mRNA vaccines, although we tried to improve the balance by asking what kind of vaccine they would intend to do.

On the other hand, an important strength was the very large sample and its origin, as it concerned all health districts and all levels of health care. We also consider, the time of the study very important. Before our study and as no vaccines were available, there was only discussion in theory, and a few months after our study, vaccination for HCWs, was mandatory. We believe that we have managed to record the intention, but also the hesitancy at a very critical point in time.

7 CONCLUSIONS

This study assessed the intention of doctors, nurses, and nursing assistants who were working in the public health system of Greece, to get vaccinated with a COVID-19 vaccine in the first 2 months after vaccine availability. 72.1% of HCWs were willing to get vaccinated, while the rest 27.9% were hesitant. Variables associated with reduced vaccination intention are female gender, age (<40), pregnancy, conspiracy theories, reluctance to refuse or postpone vaccination in the past, low level of education, invalid individual information, low level of training from the employer, and low level of knowledge about the virus and the vaccine. Also, special attention should be paid to the low vaccination rates of health professionals for seasonal flu, as this factor is also negatively related. Conversely, physicians (compared to nursing staff), university graduates, post-graduate and doctoral students, HCWs who were informed through EODY and WHO, as well as those who had experienced a congenital disease or death due to the virus, and increased intention to be vaccinated.

In conclusion, our study showed that once a vaccine was available, most HCWs were willing to be vaccinated, and it also identified several reasons for hesitation. These findings could be used in the future to tailor communication and promotion campaigns, using anthropocentric strategies.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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