Factors Associated with Healthcare Workers’ (HCWs) Acceptance of COVID-19 Vaccinations and Indications of a Role Model towards Population Vaccinations from a Cross-Sectional Survey in Greece, May 2021

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Abstract: A Knowledge, Attitudes and Practices (KAP) study was conducted at the end of May 2021 engaging 1456 healthcare workers (HCWs) from 20 hospitals throughout Greece. Acceptance of vaccination against coronavirus disease 2019 (COVID-19) was estimated at 77.7%, with lower vaccine acceptance identified in nurses compared to physicians. Fears related to vaccine safety, lack...
of information and general knowledge about vaccinations, influenza vaccine acceptance, education level and years of practice were among the factors independently associated with vaccine acceptance. A strong association was identified between vaccination of HCWs in each health region and the population coverage, indicating that HCWs may be role models for the general population. Information campaigns should continue despite decisions taken regarding mandatory vaccinations.

**Keywords:** COVID-19; SARS-CoV-2; vaccine; vaccination; healthcare workers; acceptance; vaccine safety; doctors; nurses; role model

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### 1. Introduction

As of 31 May 2021, a total of 169,597,415 coronavirus disease 2019 (COVID-19) cases and 3,530,582 deaths have been confirmed globally. Approximately 15 months after announcing the first COVID-19 case in Greece, 402,306 cases and 12,095 deaths had been reported in the country, respectively.

The need for containment of the COVID-19 pandemic, as well as a lack of any targeted antiviral therapeutics, highlights the importance of developing safe and effective vaccines along with well-designed vaccination programs [1–3]. Vaccines constitute highly effective tools for controlling and eliminating vaccine-preventable diseases. They are among the most cost-effective public health investments, and their value is increasing during this pandemic period. A novel type of COVID-19 vaccine based on mRNA technology (BNT162b2, Pfizer, New York, NY, USA and Biotech, Mainz, Germany) was the first to receive emergency use authorization by the Food and Drug Administration (FDA) on 11 December 2020. This was followed by the mRNA-1273 vaccine (Moderna, Cambridge, MA, USA) on 18 December 2020 and additional non-mRNA vaccines (ChAdOx1 nCoV-19, AstraZeneca, Cambridge, United Kingdom and University of Oxford, Oxford, United Kingdom, on 28 January 2021 and Ad26.COV2.S, Janssen Pharmaceuticals, Beerse, Belgium, on 27 February 2021). In Greece, the first BNT162b2 vaccine doses were administered on 27 December 2020, and from early to mid-February, vaccination with mRNA-1273 and ChAdOx1 nCoV-19 began. On 5 May 2021, the first Ad26.COV2.S vaccines were administered in the country.

An initially limited availability of vaccines required all countries to organize prioritized vaccination schedules for their respective populations. The first phase of the Greek vaccination program prioritized healthcare workers (HCWs) as a group characterized by higher risk of infection, followed by other high risk and vulnerable groups, and lastly, the general Greek population [4]. In order to achieve vaccine-acquired herd immunity, immunization coverage must reach fixed threshold rates [5]. HCWs could possibly act as role models and influence attitudes of the general population towards vaccine acceptance.

As of the end of May 2021, 190,850 HCWs (77.0%) in Greece had received at least one vaccine dose [6]. Several relevant studies regarding vaccination compliance in Europe [7–9] and Canada [10] demonstrated relatively high vaccination coverage among HCWs, while still not reaching the optimal percentage [5]. HCWs’ hesitancy towards COVID-19 vaccination—meaning the delay in acceptance or refusal of vaccination despite availability of vaccination services—remains an important public health issue globally [11]. Relevant studies observed that the most frequently cited factors for vaccination hesitancy were related to the vaccines’ safety profiles [12,13].

The aim of our study was to examine COVID-19 vaccine acceptance by HCWs in Greece and identify determinants related to vaccine hesitancy. Moreover, our intention was to study knowledge, attitudes and practices on aspects towards vaccination, following the third pandemic wave and two lockdown periods. Finally, a possible role model of HCWs towards population vaccination could also be explored.
2. Materials and Methods

2.1. Study Design

A nationwide cross-sectional Knowledge, Attitudes and Practices (KAP) study was designed.

A cross-sectional questionnaire-based KAP study was conducted in May 2021, when all four of the aforementioned vaccines were available in Greece, in order to assess the knowledge, attitudes and practices of HCWs in Greek public hospitals (physicians, nurses, medical laboratory workers, midwives, administrative workers, community nurses, cleaning staff and others) related to acceptance of COVID-19 vaccines. A sample size of 1045 was calculated using a Raosoft Digital Sample Size Calculator (Raosoft Inc, Seattle, WA, USA) in which 3% was used as a margin of error, 95% as the confidence interval (CI), 50% as the expected frequency and 50,000 as the population size. Using an expected response rate of approximately 30%, a sample of 3500 was calculated. A geographically stratified sampling plan based on Greek health districts was applied to produce a representative sample. Health personnel from at least one general hospital and one university hospital (where applicable) in each health district were asked to participate in the study. Questionnaires were disseminated proportionally in each hospital according to the number of employees. A total of 20 hospitals were selected for inclusion in the study.

An anonymized paper-based questionnaire was developed with 25 closed-ended questions (Supplementary Materials Questionnaire S1) addressing: (1) demographic characteristics (age, gender, marital status, educational level, healthcare profession, health district of employment, department of employment, section of employment and years of practice); (2) questions focused on participants’ or their surrounding social environment, health status, general knowledge about vaccines and attitudes towards vaccination and (3) questions focused specifically on COVID-19 and COVID-19 vaccines. The Likert scale, a rating scaling method measuring either positive or negative responses to a statement, was used for questions related to vaccines. For each question, five possible answers existed on an ordered scale with respect to the degree of agreement as follows: “completely agree”, “agree”, “neither agree nor disagree”, “disagree” and “completely disagree”. Only one question related to COVID-19 vaccine acceptance was limited to two possible responses: “yes” or “no”. A paper-based version of the questionnaire was disseminated at the selected hospitals to personnel on duty the day of dissemination.

2.2. Ethical Statement

The questionnaire was anonymous and verbal consent was obtained for participation. The study protocol was approved by the Ethics Committee of the Medical Department of the University of Thessaly (decision number 48, 13 January 2021).

2.3. Statistical Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as means ± standard deviations, and categorical variables as frequencies and percentages. The relationship between the main outcome measure (acceptance of COVID-19 vaccine) and participants’ characteristics (baseline characteristics, perception and knowledge about COVID-19 vaccine) were assessed using either Chi-square analysis or Student’s t-test. Student’s t-test was performed for continuous data since there was no deviation from normal distribution (Shapiro–Wilk normality test) and violation of the assumption of homogeneity of variance (Levene’s test). In univariate analysis, the percentage of vaccinated and the proportional ratio (PR) with 95% confidence intervals (CIs) were presented. The direction of the association was analyzed using bivariate logistic regression analysis with a 95% CI. Selection of variables for the bivariate logistic regression model was based on factors previously reported in the literature and found to be significant in the Chi-square analysis or Student’s t-test. Spearman’s correlation coefficient was used to measure the strength and direction of association between percentage of vaccinated HCWs and percentage of vaccinated adults (at least
one dose) in each health district. Population data for each prefecture was obtained from Hellenic Statistical Authority (Piraeus, Greece) and vaccination data from the Hellenic Ministry of Health. All tests were 2-sided and a p-value of <0.05 was considered to indicate statistical significance.

A few survey questions (specifically questions 14, 15, 22 and 24) were rated on a five-point scale as follows: “completely disagree”, “disagree”, “neither agree nor disagree, agree” and “completely agree”. The responses “completely disagree”, “disagree” or “neither agree nor disagree” were considered to indicate disagreement, while responses of “completely agree” or “agree” were taken as agreement. Survey questions 14, 15 and 22 each consisted of three sub questions. The correct answers to all three sub questions were considered as a correct answer, whereas answering at least one of the three sub questions incorrectly was considered as an incorrect answer.

The questionnaire was designed based on our previous knowledge [14,15] and done by an expert team comprised of an epidemiologist, an occupational health professional and a public health specialist. To provide feedback on clarity and usefulness of questions included, the questionnaire was pre-tested with 15 HCWs. Pre-testing results were considered for further modification of the protocol and questionnaire. Internal consistency reliability of the questionnaire was assessed by estimating Cronbach’s alpha value of 0.70, which was considered acceptable [16].

3. Results

3.1. Basic Demographics

A total of 3500 questionnaires were disseminated in 20 hospitals among 1456 HCWs participating in the study (response rate: 41%). Most participants were female (71.8%) and the average age was 43.1 years. Participants’ occupations covered the entire spectrum of care, including nursing staff (49.2%), physicians (31.8%), laboratory staff (5.8%), administrative staff (5.4%), midwives (1.7%), community nurses (1.5%), cleaning staff (1.2%) and others (ambulance workers, physiotherapists, pharmacists, dieticians, biologists, social workers) (3.4%). Nearly 4 out of 5 participants (78.2%) had occupational exposure to patients infected with COVID-19. Out of 1456 participants, 1132 (77.7%) declared that they were fully vaccinated or intended to receive a COVID-19 vaccine.

3.2. Variables Associated with COVID-19 Vaccine Acceptance

Through univariate analysis, it was shown that higher educational attainment, such as Master/Doctoral and university level compared to high school level was significantly positively associated with COVID-19 vaccine acceptance among HCWs. Tables 1–4 demonstrate this, indicating the percentage of vaccinated HCWs and proportional ratio compared to the reference group for categorical variables (with p-value <0.05): Master/Doctoral level education at 87.3% (PR = 1.38) and university level at 88.4% (PR = 1.40), compared to high school level at 63.2%. Similarly, and as indicated in Table 1, a greater number of years in healthcare practice was significantly associated with vaccine acceptance (vaccinated HCWs with 16.2 years, compared to non-vaccinated HCWs with 14 years). Correctly responding to general knowledge vaccination questions (Q14: 83.8% PR = 1.09 and Q15: 94%, PR = 1.33), acceptance of seasonal flu vaccination (89.2%, PR = 1.51) and having a relative or friend who had COVID-19 (79.8%, PR = 1.16) were all factors significantly positively associated with COVID-19 vaccine acceptance. Furthermore, Tables 1–4 show a significant positive association with vaccine acceptance among HCWs who were better informed when compared to HCWs with limited or even no information (insufficient information: 66.3%, PR = 1.27; satisfactory level of information: 85.6%, PR = 1.64; excellent level of information: 90.2%, PR = 1.73, compared to no information: 52.2%).
Table 1. Demographical characteristics (gender, age, marital status, educational level) associated with COVID-19 vaccine acceptance, expressed with proportional ratio in univariate analysis.

| Variables                  | Vaccinated N (%) or Mean (StD) | Proportional Ratio (PR) 95% CI | Sig. |
|----------------------------|--------------------------------|--------------------------------|------|
| Age                       | Vac: 43.2 Non vac: 42.09       | 10.5 9.3                       | -0.070 |
| Gender                    | Male 328 80.0 Female 804 76.9  | 1.04 (0.98–1.10)               | 0.206 |
| Marital status            | Married 696 78.6 Divorced 52 81.3 Widowed 2 66.7 Unmarried 375 76.5 | 1.03 (0.97–1.09) 1.06 (0.94–1.21) 0.87 (0.39–1.94) | 0.387 0.398 0.554 (f) |
| Educational level         | Master/Doctoral 289 87.3 Higher Education Institute/ University (BSc, AEI) 335 88.4 | 1.38 (1.20–1.59) 1.40 (1.22–1.61) | <0.001 <0.001 |
| Educational level (groups) | Higher Education Institute/ University (AEI) and Master or Doctoral High School and Institute of Vocational Training (IEK) and Technological Educational Institute (TEI) 624 87.9 | 1.29 (1.22–1.36) | <0.001 |

Std: Standard Deviation; CI: Confidence Interval; Sig.: Significance; Vac: Vaccinated; Non Vac: Non vaccinated.

Table 2. Profession characteristics (profession, health district of employment (Y.IIE), department and section of employment, years of practice) associated with COVID-19 vaccine acceptance, expressed with proportional ratio in univariate analysis.

| Variables                  | Vaccinated N (%) or Mean (StD) | Proportional Ratio (PR) 95% CI | Sig. | Variables                  | Vaccinated N (%) or Mean (StD) | Proportional Ratio (PR) 95% CI | Sig. |
|----------------------------|--------------------------------|--------------------------------|------|----------------------------|--------------------------------|--------------------------------|------|
| Healthcare profession      | Nursing staff 495 69.1 Laboratory staff 56 65.9 Midwife 20 80.0 Administrative 64 82.1 Community nurse 22 100 1.08 Cleaning staff 7 41.2 Other health professionals 40 81.6 Physician 428 92.4 | 0.75 (0.71–0.79) 0.71 (0.61–0.83) 0.87 (0.71–1.06) 0.89 (0.80–0.99) 1.08 (1.05–1.11) 0.45 (0.25–0.79) 0.88 (0.77–1.01) 92.4 | <0.001 <0.001 0.027 0.003 0.181 <0.001 0.010 Ref. |
| Healthcare profession (groups) | Not Physician 704 71.0 Physician 428 92.4 | 0.77 (0.73–0.81) | <0.001 |
| Health district of employment (Y.IIE) | 2nd 115 88.5 3rd 183 70.4 4th 235 75.3 5th 266 74.9 6th 82 80.4 7th 150 84.3 1st 101 85.6 | 1.03 (0.94–1.14) 0.82 (0.74–0.92) 0.88 (0.80–0.97) 0.88 (0.80–0.96) 0.94 (0.83–1.06) 0.99 (0.89–1.09) | 0.501 0.002 0.021 0.016 0.304 0.756 Reference group |
| Health district of employment (Y.IIE) (groups) | (2nd, 3rd, 4th, 5th) 684 73.8 0.87 (0.83–0.92) | <0.001 |
| Department of employment   | Laboratory 135 78.9 Other 222 75.8 Clinical 774 78.2 | 1.01 (0.93–1.10) 0.97 (0.90–1.04) 8.2 Reference group |

Ref.: Reference group
Table 2. Cont.

| Variables                        | Vaccinated N (%) or Mean (Std) | Proportional Ratio (PR) 95% CI | Sig. | Variables                        | Vaccinated N (%) or Mean (Std) | Proportional Ratio (PR) 95% CI |
|----------------------------------|-------------------------------|---------------------------------|------|----------------------------------|-------------------------------|--------------------------------|
| **Section of employment**        |                               |                                 |      | **Years of practice**            |                               |                                 |
| Surgery                          | 237                           | 73.8                            | 0.94 | Pathology                        | 554                           | 78.8                            |
| Laboratory                       | 139                           | 79.4                            | 1.01 |                                  |                               |                                 |
| Other                            | 254                           | 17.5                            | 1.01 |                                  |                               |                                 |
| Laboratory                       | 139                           | 79.4                            | 1.01 |                                  |                               |                                 |
| Other                            | 254                           | 17.5                            | 1.01 |                                  |                               |                                 |
| Pathology                        | 554                           | 78.8                            |      |                                  |                               |                                 |
| Years of practice                | Vac: 16.2                     | 11.1                            |      | Non vac: 14.0                    | 10.2                          | 0.001                           |
|                                  |                               |                                 |      |                                  |                               |                                 |

Std: Standard Deviation; CI: Confidence Interval; Sig.: Significance; Vac: Vaccinated; Non Vac: Non vaccinated.

Table 3. Section A questions “participants’ knowledge about vaccines and their attitude to vaccination” associated with COVID-19 vaccine acceptance, expressed with proportional ratio in univariate analysis.

| Variables                                                                 | Vaccinated N (%) | Proportional Ratio (PR) 95% CI | Sig. |
|----------------------------------------------------------------------------|------------------|---------------------------------|------|
| 12. Do you belong to a vulnerable/high risk group due to your medical history? | Yes: 177, No: 954 | 76.6 78.0 0.98 (0.91–1.06) 0.643 |      |
| 13. Do you live with older individuals or individuals belonging to a vulnerable/high risk group due to their medical history? | Yes: 299, No: 833 | 75.3 78.7 0.96 (0.90–1.02) 0.162 |      |
| 14. (Correct answer/incorrect answer) (*) Correct: 150, Incorrect: 982   | 83.8 77.0 1.09 (1.01–1.17) 0.039 |      |
| 14a. The HPV vaccine is recommended for all males up to 18 years of age in the country | Correct: 269, Incorrect: 820 | 79.1 73.7 1.26 (1.03–1.55) 0.031 |      |
| 14b. After the flu vaccination, certain foods are not permitted to be consumed for a period of 24 hours | Correct: 607, Incorrect: 525 | 87.0 69.4 1.25 (1.19–1.33) <0.001 |      |
| 14c. One of the contraindications of the flu vaccine is an allergy to eggs | Correct: 519, Incorrect: 613 | 86.8 71.5 1.21 (1.15–1.28) <0.001 |      |
| 15. (Correct answer/incorrect answer) (*) Correct: 408, Incorrect: 724 | 94.0 70.9 1.33 (1.27–1.39) <0.001 |      |
| 15a. Vaccinations are an important tool for the protection of public health and in particular of health professionals and workers in the health sector | Correct: 1094, Incorrect: 38 | 81.5 33.6 2.42 (1.87–3.15) <0.001 |      |
| 15b. Natural immunity acquired via disease is always preferable to immunity acquired via vaccination | Correct: 600, Incorrect: 528 | 90.6 66.9 1.35 (1.28–1.43) <0.001 |      |
| 15c. Many vaccines often have serious side effects | Correct: 591, Incorrect: 537 | 89.0 68.2 1.30 (1.24–1.38) <0.001 |      |
| 16. Are you the parent/guardian of one or more children? | Yes: 658, No: 474 | 78.0 77.6 1.01 (0.95–1.06) 0.862 |      |

Do you adhere to the child vaccination program suggested by the National Vaccination Program in the country?

|                    | Yes: 644 | 78.1 1.24 (0.88–1.75) 0.123 |
|--------------------|----------|-----------------------------|------|
| I select and carry out some vaccinations | 12 | 63.2 Reference group |
| I do not vaccinate my children | 0 | 0.0 |


Table 3. Cont.

| Variables                                      | Vaccinated N (%) | Proportional Ratio (PR) 95% CI | Sig.  |
|------------------------------------------------|------------------|--------------------------------|-------|
| 17. Have you been vaccinated with the seasonal flu vaccine? |                   |                                |       |
| Yes: 803                                      | 89.2             | 1.51 (1.40–1.62)               | <0.001|
| No: 329                                       | 77.8             |                                |       |

StD: Standard Deviation; CI: Confidence Interval; Sig.: Significance; Vac: Vaccinated; Non Vac: Non vaccinated. (*) The correct answers to all three sub questions were considered as a correct answer, whereas answering at least one of the three sub questions incorrectly was considered as an incorrect answer.

Table 4. Section B questions “knowledge and hesitancy regarding vaccines against SARS-CoV-2” associated with COVID-19 vaccine acceptance, expressed with proportional ratio in univariate analysis.

| Variables                                      | N (%)          | Proportional Ratio (PR) 95% CI | Sig.  |
|------------------------------------------------|----------------|--------------------------------|-------|
| 18. Do you know of a relative or friend who has had COVID-19? | Yes: 942       | 79.8                           | 1.16 (1.06–1.26) | <0.001 |
|                                                  | No: 190        | 69.1                           |       |
| 19. Do you come into contact with COVID-19 patients while performing your job duties? | Yes: 898       | 78.9                           | 1.07 (1.00–1.15) | 0.054  |
|                                                  | No: 234        | 73.8                           |       |
| 20. How do you evaluate your level of being informed about vaccines against the SARS-CoV-2 virus that causes COVID-19? | No information | 52.2                           | Reference group |
|                                                  | Insufficient   | 66.3                           | 1.27 (1.01–1.61) | 0.021  |
|                                                  | Satisfactory   | 85.6                           | 1.64 (1.31–2.06) | <0.001 |
|                                                  | Excellent      | 90.2                           | 1.73 (1.37–2.18) | <0.001 |

Medical articles in journals; committee for infectious diseases at health facility; website of the Hellenic National Public Health Organization (NPHO); website of the Hellenic Ministry of Health

21. Which channels do you use to keep informed about the COVID-19 pandemic and the SARS-CoV-2 vaccine, and how often?

| Variables                                      | N (%)          | Proportional Ratio (PR) 95% CI | Sig.  |
|------------------------------------------------|----------------|--------------------------------|-------|
| 22. (Correct answer/incorrect answer) (*)      | Correct: 571   | 90.3                           | 1.33 (1.26–1.40) | <0.001 |
|                                                  | Incorrect: 561 | 68.2                           |       |
| 22a. Some of the vaccines against SARS-CoV-2 which are approved and used in the country are based on mRNA technology | Correct: 1000 | 79.2                           | 1.16 (1.05–1.28) | 0.001  |
|                                                  | Incorrect: 129 | 68.3                           |       |
| 22b. The dosage regimen of the vaccines against SARS-CoV-2 includes 3 doses | Correct: 772   | 89.1                           | 1.10 (1.03–1.17) | 0.002  |
|                                                  | Incorrect: 357 | 73.2                           |       |
| 22c. There is evidence that mRNA technology interferes with the DNA of cells | Correct: 763   | 80.2                           | 1.45 (1.36–1.55) | <0.001 |
|                                                  | Incorrect: 366 | 61.4                           |       |
| 24. Does the short period of time for development of the vaccines cause you any concerns about its safety? | Disagree: 744  | 90.8                           | 1.49 (1.39–1.59) | <0.001 |
|                                                  | Agree: 388     | 61.0                           |       |
| 25. Do you believe that vaccination against SARS-CoV-2 should be mandatory for healthcare professionals? | Yes: 667       | 95.6                           | 1.56 (1.47–1.65) | <0.001 |
|                                                  | No: 465        | 61.4                           |       |

StD: Standard Deviation; CI: Confidence Interval; Sig.: Significance; (*) The correct answers to all three sub questions were considered as a correct answer, whereas answering at least one of the three sub questions incorrectly was considered as an incorrect answer.

A weak positive correlation was identified between the source of information, specifically official and evidence-based data sources compared to general interest media (80%, PR = 1.08 and 74.3%, respectively). In addition, correctly responding to questions related to knowledge of COVID-19 vaccination (Q22: 90.3%, PR = 1.33), having no concerns about
safety of vaccines against SARS-CoV-2 (90.8%, PR = 1.49) and belief in mandatory vaccination against SARS-CoV-2 for healthcare professionals (95.6%, PR = 1.56) were all factors identified as associated with acceptance of COVID-19 vaccination. Compared to physicians of which 92.4% were vaccinated, lower vaccine acceptance was identified among other healthcare professionals such as nursing staff (69.1%, PR = 0.75), laboratory workers (65.9%, PR = 0.71), midwives (80%, PR = 0.87), administrative staff (82.1%, PR = 0.89), cleaning staff (41.2%, PR = 0.45) and other health professionals (81.6%, PR = 0.88). Furthermore, it was shown that employees from the 3rd, 4th and 5th health districts were less likely to be vaccinated compared to employees from 1st health district 85.6% (3rd: 70.4%, PR = 0.82; 4th: 75.3%, PR = 0.88; 5th: 74.9%, PR = 0.88).

As seen in Table 5, multivariate analysis demonstrated that compared to physicians, other healthcare professions such as nursing staff (adjusted odds ratio (aOR) = 0.38, 0.21–0.67), laboratory staff (aOR = 0.36, 0.17–0.78) and cleaning staff (aOR = 0.24, 0.07–0.88) were independently associated with acceptance of the COVID-19 vaccine. Moreover, factors including health district of employment (aOR = 0.42, 0.29–0.61), correctly responding to general knowledge questions about vaccinations (Q15 aOR = 2.52, 1.54–4.14), years of practice (aOR = 1030, 1004–1056), correctly answering questions about knowledge of COVID-19 vaccines (aOR = 1.83, 1.27–2.64), acceptance of seasonal flu vaccination (aOR = 3.48, 2.53–4.79), having a relative or friend who had COVID-19 (aOR = 1.88, 1.27–2.78) and having no concerns about the safety of vaccines against SARS-CoV-2 (OR = 4.69, 3.38–6.52) were independently associated with acceptance of the COVID-19 vaccine.

### Table 5. Factors associated with COVID-19 vaccine acceptance, expressed with adjusted odds ratio in multivariable analysis.

| Factor | Univariate | Multivariate |
|--------|------------|--------------|
|        | OR 95% CI  | aOR 95% CI   | Sig.  |
| Age    | -          | 1.01 (0.98–1.04) | 0.625 |
| Gender (Male/Female) | 1.20 (0.91–1.59) | 0.79 (0.55–1.13) | 0.196 |
| Education level ((BSc, MSc, PHD) vs. (High School and TEI and IEK)) | 3.39 (2.58–4.46) | 1.20 (0.78–1.83) | 0.412 |
| Physician | Reference group | | |
| Nursing staff | 0.18 (0.13–0.27) | 0.38 (0.21–0.67) | <0.001 |
| Laboratory staff | 0.16 (0.09–0.28) | 0.36 (0.17–0.78) | 0.010 |
| Midwife | 0.33 (0.12–0.92) | 0.52 (0.15–1.80) | 0.301 |
| Administrative | 0.37 (0.19–0.73) | 1.18 (0.52–2.67) | 0.697 |
| Community nurse | - | - | 0.998 |
| Cleaning staff | 0.06 (0.02–0.16) | 0.24 (0.07–0.88) | 0.031 |
| Other health professionals | 0.36 (0.16–0.81) | 0.56 (0.21–1.46) | 0.235 |
| Health district of employment (Υ.Π.Ε) (3, 4, 5)/(1, 2, 6, 7) | 0.50 (0.38–0.67) | 0.42 (0.29–0.61) | <0.001 |
| Years of practice | - | 1.030 (1.004–1.056) | 0.021 |
| 12. Do you belong to a vulnerable/high risk group due to your medical history? (yes/no) | 0.92 (0.66–1.29) | 0.78 (0.51–1.19) | 0.251 |
| 13. Do you live with older individuals or individuals belonging to a vulnerable/high risk group due to their medical history? (yes/no) | 0.82 (0.63–1.08) | 0.97 (0.69–1.37) | 0.852 |
| 14. (Correct answer/incorrect answer) (*) | 1.55 (1.02–2.35) | 0.94 (0.55–1.59) | 0.807 |
| 15. (Correct answer/incorrect answer) (*) | 6.44 (4.24–9.79) | 2.52 (1.54–4.14) | <0.001 |
| 17. Have you been vaccinated with the seasonal flu vaccine? (yes/no) | 5.69 (4.34–7.45) | 3.48 (2.53–4.79) | <0.001 |
| 18. Do you know of a relative or friend who has had COVID-19? (yes/no) | 1.77 (1.32–2.37) | 1.88 (1.27–2.78) | 0.001 |
Table 5. Cont.

| Question                                                                 | Univariate | Multivariate |
|-------------------------------------------------------------------------|------------|--------------|
| 19. Do you come into contact with COVID-19 patients while performing your job duties? (yes/no) | 1.33 (1.00–1.77) | 1.24 (0.86–1.81) |
| 21. Which channels do you use to keep informed about the COVID-19 pandemic and the SARS-CoV-2 vaccine (Medical articles in journals; committee for infectious diseases at health facility; website of the Hellenic National Public Health Organization (NPHO); Ministry of Health); television; social media channels; newspapers; general interest publications/journals/ websites) | 1.39 (1.08–1.78) | 0.76 (0.56–1.04) |
| 22. (Correct answer/incorrect answer) (*) | 4.37 (3.23–5.91) | 1.83 (1.27–2.64) |
| 24. Does the short period of time for development of the vaccines cause you any concerns about its safety? (disagree/agree) | 6.34 (4.76–8.44) | 4.69 (3.38–6.52) |

CI: Confidence Interval; Sig.: Significance; aOR = adjusted odds ratio; OR = odds ratio. (*) The correct answers to all three sub questions were considered as a correct answer, whereas answering at least one of the three sub questions incorrectly was considered as an incorrect answer.

Concerns regarding vaccine safety (37.8%) were reported as the primary reason for rejecting vaccination. Another major concern cited was the need for further information about vaccination (30%), fear of a possible allergic reaction to the vaccine (8.7%) and confidence that they were not at high risk of severe COVID-19 disease/becoming infected with SARS-CoV-2 (9.3%). Additional reasons for rejecting vaccination cited by fewer number of respondents included current pregnancy and breastfeeding status (3.1%), and apathy towards vaccination (0.6%).

According to National Vaccination Registry data, the countrywide proportion of vaccinations in the general adult population was 42% [17]. A strong positive relationship between percentage of vaccinated HCWs and percentage of vaccinated adults (at least one dose) in each health district was identified (Spearman’s correlation coefficient \( \rho = 0.881, p = 0.009 \)).

3.3. Internal Consistency Reliability

Internal consistency of the questionnaire was established by calculating Cronbach’s alpha coefficient. The reliability coefficient was calculated at 0.722, suggesting an acceptable internal consistency.

4. Discussion

Vaccine hesitancy can present a major barrier to pandemic control, particularly when expressed by HCWs, as it inhibits the attainment of population level “herd immunity”. In our study, we estimated COVID-19 vaccine acceptance at 77.7%, which is very close to the reported vaccine coverage of HCWs in Greece (77%) at the end of May 2021 [6].

The majority of published studies investigate acceptance of COVID-19 vaccines among HCWs using assessed intention, rather than actual vaccine uptake. We calculated that nearly six months after implementation of the vaccination program, four out of five HCWs were vaccinated or intended to receive the vaccine. Our estimated overall coverage is compatible with findings of other studies conducted in Canada [10] and France [18,19]. Moreover, according to review articles summarizing findings on COVID-19 vaccination hesitancy, 22.5% of HCWs and 18.9% of healthcare professional students and trainees worldwide reported vaccination hesitancy [12,13].

Factors including sex or older age which may influence an individual’s perceived risk of COVID-19 (and hence need for vaccination) were not associated with vaccine acceptance in our study. This finding is supported by another survey in South Africa [20]. However, several studies reported higher vaccine acceptance by males and older HCWs [12,13,21]. Rather than a correlation with age, we found that years of practice was a possible positive
predictor for COVID-19 vaccination, which, at this moment, has not been identified in other studies to the best of our knowledge. It is possible that years of practice is associated with better knowledge regarding vaccinations, vaccine efficacy and safety.

In our study, COVID-19 vaccine acceptance increased with education level in accordance with findings from other studies [12,13,21]. In general, the higher the level of education attained by HCWs, the more possibilities existed for vaccine acceptance. Differences in vaccination rates between occupational categories have been observed for the seasonal influenza vaccine; a less favorable attitude towards the influenza vaccine among nurses as compared to physicians has been reported previously [22]. The specific phenomenon of nurses being COVID-19 vaccine acceptors less often than physicians has been observed in several studies in the United Kingdom [23], Canada [10] and Hong Kong [24]. This observation is of particular clinical importance and mirrors the risk for patients, as nurses have prolonged and often longer contact with patients than physicians. It should be noted that in France, nurses and assistant nurses were the most affected occupational categories among HCWs infected by SARS-CoV-2 [25]. This fact, in accordance with low vaccine uptake, endangers the lives of both nurses and patients.

The most effective predictive indicator for vaccination in our study was history of vaccination against influenza virus; this finding is supported by previous studies [21,23]. Interestingly, COVID-19 vaccination acceptance rates exceed influenza vaccination acceptance rates in Greece [14] as in other countries [9,19]. The reason could be the perceived risk from COVID-19 compared to influenza; HCWs usually perceived themselves to be at low risk of contracting severe influenza.

The statistically significant finding that HCWs with a better level of knowledge about vaccines are more willing to receive the vaccine highlights the urgent need to provide further information about safety and efficacy of new vaccines. HCWs are a heterogeneous group and in an important part of them, topics related to immunizations were not incorporated in their initial training. It should be noted that a dose response relationship was revealed between the level of knowledge or information received on COVID-19 vaccines and vaccine acceptance, indicating a strong association. In an earlier study among Greek HCWs to investigate their intention to be vaccinated (conducted prior to the beginning of COVID-19 vaccinations), a lower proportion (51.1%) reported willingness to receive the vaccine [26]. The observed difference between this percentage and our result could be attributed to this earlier study period when less information on safety and efficacy of COVID-19 vaccines was available. Moreover, geographic coverage of this early HCW study in Greece was insufficient as only eight hospitals participated in the study. In contrast, our study included one university hospital and at least one general hospital from each region (20 tertiary-care hospitals). Education plays an important role in promoting vaccinations and the competent authorities should continue education campaigns for HCWs to improve knowledge and reduce fear related to vaccine safety and efficacy.

Identification of factors associated with vaccination hesitancy could guide ongoing vaccination campaigns. The primary factor for refusal of vaccination was fear regarding vaccine safety; this finding was common across many studies related to COVID-19 vaccine acceptance [12,13,18,27] and is closely related with lack of information mentioned above. To overcome this clear obstacle in vaccination strategy, national authorities must invest in providing more evidence-based information related to vaccine efficacy and safety. Early recognition of barriers and immediate implementation of training plans are critical to inform and persuade the greatest number of HCWs possible, and therefore increase vaccine uptake rates as quickly as possible. Clarification regarding side effects of vaccinations will improve long-term trust in COVID-19 vaccines.

Another noteworthy result identified is that in health districts where a higher proportion of HCWs were vaccinated or willing to receive the vaccine, a greater number of citizens were also vaccinated with at least one dose of COVID-19 vaccine (data from the National Vaccination Registry). This finding is important as it indicates a possible
role model for the HCWs. Greece and other EU Member States recently decided to make COVID-19 vaccination mandatory for HCWs. This decision increased vaccination coverage of HCWs and protection against COVID-19. However, vaccination requirements do not improve knowledge about vaccines and thus do not convince HCWs about vaccine safety, efficacy or the general need for vaccination among HCWs and the general population. Thus, information campaigns should be continued in parallel with mandatory vaccination to improve HCWs’ knowledge and reduce their fears related to vaccination, in order to indirectly influence vaccine acceptance of the general population [27].

Our study has several limitations. The sample was convenient and the response rate was relatively low (41%). A participation bias may exist in those who were not willing to accept the vaccine, as they may have been less likely to answer the questionnaire. However, the percentage of acceptance identified was very close to the vaccination coverage of HCWs in Greece as reported by the World Health Organization (WHO) [6]. The questionnaire used was pre-tested, however, a test and retest process was not conducted to check validity of the questionnaire. Moreover, potentially useful information on Hepatitis B vaccination, questions about the intention of HCWs to recommend COVID-19 vaccination and revealing elements of character, such as altruistic and self-serving behavior, were not included. Finally, our study did not include qualitative assessment of reasons for vaccine hesitancy, such as reservations related to religion which could be considered a possible factor.

5. Conclusions

Acceptance of COVID-19 vaccines among HCWs in Greece could be considered satisfactory, especially among physicians. Areas for improvement exist among nurses and other healthcare professions/staff. As a result, efforts should continue through information campaigns, despite the decision taken for mandatory vaccination of HCWs. An indication that HCWs could be role models for the general population was identified; thus, national authorities should continue their efforts to persuade HCWs about vaccine efficacy and safety.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/ijerph181910558/s1, Questionnaire S1: Questionnaire on knowledge, attitudes and practices of healthcare professionals related to the SARS-CoV-2 vaccine.

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