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# Predictors of Willingness of the General Public to Receive a Second COVID-19 Booster Dose or a New COVID-19 Vaccine: A Cross-Sectional Study in Greece

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**Abstract:** Given the concerns of waning immunity from the primary COVID-19 vaccines and the first booster dose, we conducted an on-line cross-sectional study in May 2022 to investigate willingness to receive a second COVID-19 booster dose or a new COVID-19 vaccine and its associated factors. Overall, 22.7% of participants were willing to be vaccinated, 39.3% were unsure, but tend to be willing, 25.8% were unsure, 4.9% were unsure, but tend to be unwilling, and 7.4% were unwilling to be vaccinated. The main reasons against accepting a second COVID-19 booster dose or a new COVID-19 vaccine COVID-19 dose included concerns about the side effects, the opinion that further vaccination is unnecessary, and effectiveness uncertainties. Males, younger individuals, participants without a previous COVID-19 diagnosis, and those with good/very good self-perceived physical health were significantly more frequently willing to receive a second COVID-19 booster dose or a new COVID-19 vaccine. Also, increased fear of the COVID-19, increased trust in COVID-19 vaccination and decreased fear of a second booster dose or a new COVID-19 vaccine were associated with increased willingness. Our results show some hesitancy and unwillingness toward further COVID-19 vaccination and indicate that fear of COVID-19 and trust in COVID-19 vaccination affect public opinion.

**Keywords:** second COVID-19 booster dose; vaccination; COVID-19; willingness; predictors; general population

## 1. Introduction

COVID-19 vaccine booster is adopted in several countries due to the emergence of various highly contagious variants of SARS-CoV-2. Early studies support the evidence for booster dose efficacy against the new variants (Delta and Omicron) [1,2]. On the other hand, the existing booster vaccination program produces broad but incomplete immunity against SARS-CoV-2 variants, including Omicron [3]. Moreover, real-world evidence has shown waning first booster dose effectiveness over time against new COVID-19 infections and hospitalization, especially for the Omicron variant [4].

A second booster dose could help increase protection levels especially for individuals in high-risk groups. Thus, different countries have already recommended a fourth COVID-19 mRNA vaccine dose (second booster) for older and immunocompromised individuals. For instance the U.S. Food and Drug Administration authorized a second booster dose for certain individuals considering the known and potential benefits and

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risks [5]. A second booster dose of a COVID-19 mRNA vaccine is effective in reducing rates of SARS-CoV-2 infection, severe COVID-19, short-term risk of COVID-19-related outcomes, hospitalization and mortality due to COVID-19 [6–10]. However, first COVID-19 booster uptake is low and even lower for the second dose. For instance, as of May 2022, 46.6% of individuals in the USA who are fully vaccinated opted to receive the first booster [11]. Moreover, in this population, 69.5% of individuals over 65 years of age had received the first booster dose, while the corresponding percentage for the second booster dose was 26.7%.

Thus, individuals' willingness to accept a first booster dose is an important area for research. Several studies investigated the willingness of the general public to receive a first COVID-19 booster dose [12–24]. Among these studies, the percentage of individuals who were willing to take a first booster dose ranges from 44.6% to 95.5%, while the percentage of unwilling individuals ranges from 2.1% to 30.7%. However, the intention of public to receive a second booster dose remains unknown. Moreover, a second booster or even a new COVID-19 vaccine may be very important in fall of 2022 since the emergence of new COVID-19 viral variants is always possible.

Therefore, the purpose of this study was to investigate willingness of the general public to receive a second COVID-19 booster dose or a new COVID-19 vaccine and its associated factors.

## 2. Materials and Methods

### *2.1. Study design and participants*

On 5 April 2022, the Greek Committee on Vaccination announced that a second booster dose was recommended to vulnerable groups (adults over the age of 70, adults over the age of 60 with comorbidities and elderly in nursing or care homes), provided they had their first booster dose at least four months ago. At the time of our study, a second booster offered only to vulnerable groups and not to the general population. Data for this cross-sectional study were collected from 23 May to 30 May 2022, using a convenience sample. To be eligible for inclusion, participants had to be aged 18 years or above, had to understand the Greek language and have reported a complete COVID-19 vaccine course, i.e. both doses of a two-dose COVID-19 vaccine (Pfizer/BioNTech, AstraZeneca or Moderna) and the first booster dose or one dose of a single-dose COVID-19 vaccine (Johnson & Johnson/Janssen) and the first booster dose. We used Google forms to create an anonymous version of the study questionnaire in Greek. Then, we disseminated the questionnaire through social media platforms. Also, we sent the questionnaire via e-mail to all our contacts. We included a cover letter in the online self-administered questionnaire to inform the participants that data are anonymous and participation in the study is voluntary. We conducted the study according to the principles of the Declaration of Helsinki. Moreover, the study protocol was approved by the Ethics Committee of Department of Nursing, National and Kapodistrian University of Athens (reference number; 370, 02-09-2021).

### *2.2. Predictor variables*

Predictor variables included socio-demographic variables, COVID-19 related variables, and attitudes toward COVID-19 vaccination and pandemic. Socio-demographic variables included gender (female or male), age (continuous variable), marital status (single, married, in a couple relationship without marriage, divorced, or widow), educational level (elementary school, high school, chronic disease (no or yes), self-assessment of physical health (very poor, poor, average, good, or very good), and influenza vaccination during 2021 (no or yes).

COVID-19 related variables included previous COVID-19 diagnosis (no or yes), hospitalization due to COVID-19 (no or yes), COVID-19-related death in family

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members/friends (no or yes), and adverse reactions and discomfort experienced after previous COVID-19 vaccine doses (scale from 0 [none] to 10 [great discomfort]).

Also, we measured attitudes toward COVID-19 vaccination and pandemic with a valid questionnaire [25]. The questionnaire consists of four factors: (1) fear of the COVID-19 (five items), (2) information regarding the COVID-19 pandemic and vaccination (two items), (3) compliance with hygiene measures (two items), and (4) trust in COVID-19 vaccination (seven items). In our study, Cronbach's alpha was 0.85, 0.81, 0.71, and 0.78 for the four factors respectively indicating very good reliability. Responses range from 0 (totally disagree) to 10 (totally agree). Also, a total score from 0 to 10 is calculated for each factor. Higher values indicate higher level of fear, information, compliance and trust.

Moreover, we used three study developed items to measure attitudes of participants toward a second booster dose or a new COVID-19 vaccine: I am afraid to have a second booster dose or a new COVID-19 vaccine, I worry about the long-term side effects of a second booster dose or a new COVID-19 vaccine, I feel protected by the previous COVID-19 vaccine doses. Responses in these items ranged from 0 (totally disagree) to 10 (totally agree).

### *2.3. Outcome variable*

Willingness to receive a second booster dose or a new COVID-19 vaccine was measured with a question ("If a second booster dose or a new COVID-19 vaccine is recommended as a supplement to the current vaccination schedule, would you accept it?"). Response options were the following: definitely no, probably no, unsure, probably yes, and definitely yes. We decided to investigate the willingness both for a second booster and a new COVID-19 vaccine since pharmaceutical companies seek now for the next generation of COVID-19 vaccines that will provide increased immunity against SARS-CoV-2 variants, confer a longer duration of protection, and reduce mild infection rate [26]. Thus, a new COVID-19 vaccine in fall of 2022 can be as important as a second booster or even more important.

Also, we measured the reasons participants provided for potentially refusing a second COVID-19 booster dose or a new COVID-19 vaccine with a single item ("Which of the following concerns best describe why you might refuse to accept a second COVID-19 booster dose or a new COVID-19 vaccine?"). Available answers were the following: I have doubts about the COVID-19 vaccines safety, I have doubts about the COVID-19 vaccines effectiveness, I worry about the short-term side effects, I have a low risk of infection, I am healthy and I have a low risk of COVID-19-related complications, I am not convinced that another dose will be necessary, I do need it because I believe I have immunity against the SARS-CoV-2, I have already been diagnosed with COVID-19, so I think another booster dose would not be beneficial, I am tired of the vaccination process, I worry about the long-term side effects.

### *2.4. Sample size calculation*

Median willingness of public to receive a first COVID-19 booster dose was 81% [12–24]. Considering a similar willingness for the second booster, a confidence level of 95%, and margin of error 4%, a minimum sample size of 370 participants was obtained. However, since we expected that the intention for the second booster would be lower, we assumed also a willingness rate of 50%, which results in the largest possible sample size. In that case, the minimum sample size was 601 participants.

### *2.5. Statistical analysis*

We use absolute (n) and relative (%) frequencies to present categorical variables. Continuous variables are presented as mean and standard deviation. Our aim was to investigate predictors of public willingness to receive a second COVID-19 booster dose or a new COVID-19 vaccine. Thus, we coded the outcome variable such that those who answered

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"probably yes" or "definitely yes" (willing participants to receive a second booster dose or a new COVID-19 vaccine) compared to those who answered "definitely no", "probably no" or "unsure" (unwilling or hesitant participants to receive a second booster dose or a new COVID-19 vaccine). We performed univariate and multivariable logistic regression analysis to examine associations between the predictor variables and willingness to receive a second booster dose or a new COVID-19 vaccine. We calculated unadjusted and adjusted odds ratios (aOR) with corresponding 95% confidence intervals (CI) and p-values. A p-value < 0.05 was considered statistically significant. Statistical analysis was performed with the Statistical Package for Social Sciences software (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

## 3. Results

### *3.1. Socio-demographic characteristics*

Among the 815 participants, with a mean age of 37 years, and of whom 76.1% were females, 82.4% indicated that their physical health was good/very good. The majority of the participants were singles (54%) and had a university degree (72.4%). About 33.1% of the participants received a flu vaccine during 2021, while 23.3% suffered from a chronic disease. The socio-demographic characteristics of the sample are summarized in Table 1.

**Table 1.** Sample socio-demographic characteristics (n=815).

| Characteristics | N | % |
|---|---|---|
| Gender | | |
| Males | 195 | 23.9 |
| Females | 620 | 76.1 |
| Age (years)[a] | 37.0 | 13.3 |
| Marital status | | |
| Singles | 440 | 54.0 |
| Married or in a couple relationship without marriage | 290 | 35.6 |
| Divorced | 75 | 9.2 |
| Widowed | 10 | 1.2 |
| Educational level | | |
| Elementary school | 0 | 0.0 |
| High school | 225 | 27.6 |
| University degree | 590 | 72.4 |
| Chronic disease | | |
| No | 625 | 76.7 |
| Yes | 190 | 23.3 |
| Self-perceived physical health | | |
| Very poor | 0 | 0.0 |
| Poor | 5 | 0.6 |
| Moderate | 90 | 11.0 |
| Good | 400 | 49.1 |
| Very good | 320 | 39.3 |
| Influenza vaccination during 2021 | | |
| No | 545 | 66.9 |
| Yes | 270 | 33.1 |

[a] mean, standard deviation

### *3.2. Willingness to receive a second booster dose or a new COVID-19 vaccine*

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As for the willingness to receive a second booster dose or a new COVID-19 vaccine, 22.7% of participants in our study were willing to be vaccinated, 39.3% were unsure, but tend to be willing, 25.7% were unsure, 4.9% were unsure, but tend to be unwilling, and 7.4% were unwilling to be vaccinated. Thus, 62% of the participants were willing to receive a second booster dose or a new COVID-19 vaccine, while 38% were unwilling or hesitant. The main reasons to hesitate or to be unsure over the second booster dose or a new COVID-19 vaccine were as follows: "I worry about the long-term side effects" (46.8%); "I am not convinced that another dose will be necessary" (40.3%); "I have doubts about the COVID-19 vaccines effectiveness" (30.7%); "I worry about the short-term side effects" (29%); "I am tired of the vaccination process" (27.4%); "I am healthy and I have a low risk of COVID-19-related complications" (22.6%); and "I do need it because I believe I have immunity against the SARS-CoV-2" (19.4%). Participants experienced a low level of adverse reactions and discomfort after previous COVID-19 vaccine doses. Table 2 depicts the participants' willingness to receive a second booster dose or a new COVID-19 vaccine.

### *3.3. COVID-19 related variables and attitudes toward COVID-19 vaccination and pandemic*

Nearly half of the participants (50.9%) were previously diagnosed with COVID-19 and among them, 3.6% have been hospitalized. Moreover, 31.3% of the participants had family members/friends who had died because of COVID-19. Participants experienced a moderate level of fear of both COVID-19 and a second booster dose or a new COVID-19 vaccine. Moreover, concerns about the long-term side effects of a second booster dose or a new COVID-19 vaccine were moderate. On the other hand, self-perceived protection by the previous COVID-19 vaccine doses vaccination and trust in COVID-19 vaccination were moderate to high. Also, participants reported high level of both information about the COVID-19 pandemic and vaccination and compliance with hygiene measures. Detailed information regarding COVID-19 related variables and attitudes of the participants toward COVID-19 vaccination and pandemic is shown in Table 2.

**Table 2.** COVID-19 related variables, willingness of the participants to receive a second booster dose or a new COVID-19 vaccine, and attitudes toward COVID-19 vaccination and pandemic (n=815).

| | N | % |
|---|---|---|
| Previous COVID-19 diagnosis | | |
| No | 400 | 49.1 |
| Yes | 415 | 50.9 |
| Hospitalization due to COVID-19 (n=415) | | |
| No | 400 | 96.4 |
| Yes | 15 | 3.6 |
| COVID-19-related death in family members/friends | | |
| No | 560 | 68.7 |
| Yes | 255 | 31.3 |
| If a second booster dose or a new COVID-19 vaccine is recommended as a supplement to the current vaccination schedule, would you accept it? | | |
| Definitely no | 60 | 7.4 |
| Probably no | 40 | 4.9 |
| Unsure | 210 | 25.7 |
| Probably yes | 320 | 39.3 |
| Definitely yes | 185 | 22.7 |
| Which of the following concerns best describe why you might refuse to accept a second COVID-19 booster dose or a new COVID-19 vaccine? (n=310) | | |
| I have doubts about the COVID-19 vaccines safety | 40 | 12.9 |
| I have doubts about the COVID-19 vaccines effectiveness | 95 | 30.7 |
| I worry about the short-term side effects | 90 | 29.0 |
| I have a low risk of infection | 0 | 0.0 |
| I am healthy and I have a low risk of COVID-19-related complications | 70 | 22.6 |
| I am not convinced that another dose will be necessary | 125 | 40.3 |

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| | | |
|---|---|---|
| I do need it because I believe I have immunity against the SARS-CoV-2 | 60 | 19.4 |
| I have already been diagnosed with COVID-19, so I think another booster dose would not be beneficial | 65 | 21.0 |
| I am tired of the vaccination process | 85 | 27.4 |
| I worry about the long-term side effects | 145 | 46.8 |
| Adverse reactions and discomfort experienced after previous COVID-19 vaccine doses[a] | 2.8 | 2.3 |
| Fear of the COVID-19[a] | 5.6 | 2.0 |
| Information regarding the COVID-19 pandemic and vaccination[a] | 8.1 | 1.5 |
| Compliance with hygiene measures[a] | 9.0 | 1.1 |
| Trust in COVID-19 vaccination[a] | 7.0 | 1.6 |
| Fear of a second booster dose or a new COVID-19 vaccine[a] | 3.6 | 3.3 |
| Concerns about the long-term side effects of a second booster dose or a new COVID-19 vaccine[a] | 4.0 | 3.1 |
| Self-perceived protection by the previous COVID-19 vaccine doses[a] | 7.0 | 2.3 |

[a] mean, standard deviation

### *3.4. Predictors of willingness*

Results from the multivariable logistic regression model predicting willingness of the participants to receive a second booster dose or a new COVID-19 vaccine from socio-demographic factors, COVID-19 related variables and attitudes toward COVID-19 vaccination and pandemic are shown in Table 3. We found that high levels of both fear of the COVID-19 (aOR = 1.82, 95% CI: 1.53-2.15) and trust in COVID-19 vaccination (aOR = 2.10, 95% CI: 1.69-2.61) were associated with willingness. In addition, low levels of fear of a second booster dose or a new COVID-19 vaccine was associated with willingness (aOR = 0.65, 95% CI: 0.58-0.74). Also, participants that were not previously diagnosed with COVID-19 (aOR = 3.40, 95% CI: 2.07-5.58) were more likely to be willing to receive a second booster dose or a new COVID-19 vaccine. Furthermore, participants with good/very good self-perceived physical health were nearly four times more likely than participants with very poor/poor/moderate self-perceived physical health to be willing to receive a second booster dose or a new COVID-19 vaccine (aOR = 3.92, 95% CI: 1.92-8.02). Among socio-demographic factors, gender was a significant predictor of willingness. Being male increased the likelihood of a second booster dose or a new COVID-19 vaccine acceptability by nearly 2.5 times (aOR = 2.40, 95% CI: 1.34-4.29). Moreover, decreased age was associated with increased willingness (aOR = 0.97, 95% CI: 0.95-0.99).

**Table 3.** Univariate and multivariable logistic regression analysis with willingness of the participants to receive a COVID-19 vaccine second booster dose or a new COVID-19 vaccine as the dependent variable (reference: unwilling or hesitant participants).

| Variable | Unadjusted OR (95% CI) | P-value | Adjusted OR (95% CI)[a] | P-value |
|---|---|---|---|---|
| Gender (males vs. females) | 2.48 (1.72 – 3.60) | <0.001 | 2.40 (1.34 – 4.29) | **0.003** |
| Age (years) | 1.03 (1.02 – 1.04) | <0.001 | 0.97 (0.95 – 0.99) | **0.02** |
| Marital status (married vs. singles/widowed/divorced) | 2.05 (1.50 – 2.79) | <0.001 | 1.29 (0.75 – 2.24) | 0.36 |
| Educational level (university degree vs. high school) | 1.28 (0.93 – 1.74) | 0.13 | 1.00 (0.54 – 1.85) | 0.99 |
| Chronic disease (yes vs. no) | 0.92 (0.66 – 1.29) | 0.64 | 1.26 (0.74 - 2.14) | 0.40 |
| Self-perceived physical health (good/very good vs. very poor/poor/moderate) | 2.51 (1.62 – 3.87) | <0.001 | 3.63 (1.78 – 7.42) | **<0.001** |
| Influenza vaccination during 2021 (yes vs. no) | 2.58 (1.86 – 3.57) | <0.001 | 1.59 (0.95 - 2.66) | 0.08 |
| Previous COVID-19 diagnosis (no vs. yes) | 3.07 (2.28 – 4.14) | <0.001 | 2.96 (1.84 – 4.75) | **<0.001** |
| COVID-19-related death in family members/friends (yes vs. no) | 1.19 (0.87 – 1.61) | 0.28 | 1.37 (0.82 – 2.29) | 0.24 |
| Adverse reactions and discomfort experienced after previous COVID-19 vaccine doses | 0.86 (0.81 – 0.92) | <0.001 | 1.13 (0.99 – 1.28) | 0.05 |
| Fear of the COVID-19 | 1.65 (1.50 – 1.80) | <0.001 | 1.73 (1.47 – 2.03) | **<0.001** |
| Information regarding the COVID-19 pandemic and vaccination | 1.48 (1.33 – 1.64) | <0.001 | 0.98 (0.82 – 1.17) | 0.85 |

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| | | | | |
|---|---|---|---|---|
| Compliance with hygiene measures | 1.25 (1.10 – 1.42) | 0.001 | 0.95 (0.75 – 1.22) | 0.69 |
| Trust in COVID-19 vaccination | 2.11 (1.87 – 2.38) | <0.001 | 2.11 (1.69 – 2.63) | **<0.001** |
| Fear of a second booster dose or a new COVID-19 vaccine | 0.63 (0.59 – 0.67) | <0.001 | 0.66 (0.59 – 0.75) | **<0.001** |
| Concerns about the long-term side effects of a second booster dose or a new COVID-19 vaccine | 0.71 (0.68 – 0.75) | <0.001 | 0.91 (0.81 – 1.04) | 0.16 |
| Self-perceived protection by the previous COVID-19 vaccine doses | 1.29 (1.21 – 1.38) | <0.001 | 1.04 (0.92 – 1.18) | 0.53 |

An odds ratio <1 indicates a negative association, while an odds ratio >1 indicates a positive association. Bold p-values indicate statistically significant associations.

CI: confidence interval; OR: odds ratio

[a] $R^2$ for the final multivariable model was 67.1%

## 4. Discussion

To the best of our knowledge, this is the first study that measured willingness of the general population to receive a second COVID-19 booster dose or a new COVID-19 vaccine. Moreover, we identified predictors of this willingness including socio-demographic variables, COVID-19 related variables, and attitudes toward COVID-19 vaccination and pandemic. Thus, we compared our results with studies that investigated public intention to accept the first COVID-19 booster dose.

In our study, 62% of the participants were willing to accept a second COVID-19 booster dose or a new COVID-19 vaccine, while a significant percentage (12.3%) expressed reluctance to do so and 25.7% were unsure. Our results suggest that public willingness to receive a second booster is lower than willingness to receive a first booster. In particular, median public willingness to receive a first booster was 81% [12–24]. Moreover, intention of the general population in European countries to accept a first booster is even higher than intention of our sample to accept a second booster; 95.5% in Denmark [14], 92.3% in United Kingdom [18], and 71% in Poland [20]. In addition, the actual uptake rate of a second booster or a new COVID-19 vaccine may be even lower than the willingness rate in our study, since people who say they will probably take a second booster or a new COVID-19 vaccine may eventually decide otherwise. The lower acceptance rate of second booster may be partly explained by higher public expectations of the effectiveness and the safety of the primer COVID-19 vaccine doses and the first booster. Perceived effectiveness of the COVID-19 vaccines is an important motivator but public perception of effectiveness is not always align with scientists and policy makers views [27]. For instance, the public may expect that an effective COVID-19 vaccination programme warrant the elimination of the SARS-CoV-2 and a return to normal. In addition, safety-related issues are still a key consideration in individual decision making especially for an additional booster dose or a new COVID-19 vaccine.

We found that the primary reasons for refusing a second booster or a new COVID-19 vaccine were concerns about booster/new vaccine safety, effectiveness and side effects, the belief that primer COVID-19 vaccine doses are sufficient and provide immunization, and the low self-perceived risk of COVID-19 complications. These findings are confirmed by studies investigating the refusal of individuals to accept both the first COVID-19 booster dose [15,16,20,23,24] and the primer COVID-19 vaccine doses [28–31]. It is reasonable that individuals with a complete COVID-19 vaccine course are concerned about need, safety and effectiveness of another booster or a new vaccine and policy makers should consider these issues when they design education, communication and policy-based interventions about COVID-19 vaccines [28,30]. Public concerns about COVID-19 vaccine safety are still an obstacle for booster uptake. Thus, reliable information regarding the need for and importance of boosters should be provided to previously vaccinated individuals by adhering to post-marketing surveillance and optimizing the compensation policy after side effects [32,33]. For instance, the belief that primer COVID-19 vaccine doses

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are sufficient and provide immunization is wrong since literature suggests that antibody levels and vaccines effectiveness decrease over time even after a first booster [3,4,34].

Our results showed that increased confidence in COVID-19 vaccination was highly associated with second booster acceptance. Previous studies confirm this finding since confidence in safety and effectiveness of COVID-19 vaccines and trust in pharmaceutical companies improve first COVID-19 booster acceptance rate and increase the number of vaccinated people [15,16,20,21,35,36]. Moreover, vaccine efficacy and effectiveness is an important predictor of COVID-19 vaccine acceptance and uptake [37–40]. Thus, increased vaccine efficacy and effectiveness could enhance confidence in COVID-19 vaccines leading more people to get vaccinated. Public health education and intervention programs are important to improve confidence and reduce perceived safety barriers if a second booster or a new COVID-19 vaccine is approved for the general population in the future.

Our findings also indicated that decreased fear of a second COVID-19 booster dose or a new COVID-19 vaccine was associated with increased odds of accepting vaccination. Prior studies found that adverse reactions and discomfort experienced after the primer COVID-19 vaccine doses are one of the most common causes of first booster rejection [12,16,17,20,22]. Fear of an additional booster dose is a reasonable feeling especially among individuals that experienced side effects after the primer doses or/and the first booster dose. Thus, policy makers should emphasize that COVID-19 vaccines and booster doses confer a high level of protection against COVID-19-related hospitalization, complications and death.

We found that increased fear of COVID-19 was associated with increased willingness to accept a second COVID-19 booster dose or a new COVID-19 vaccine. This finding is confirmed by the literature since higher self-perceived COVID-19 vulnerability is associated with COVID-19 vaccination uptake [41]. Moreover, higher levels of perceived threat from the COVID-19 increase parents' intention to accept vaccination for their children [42]. The level of fear of COVID-19 is high around the world and this fear has associations with mental health issues such as anxiety, stress, depression, sleep problems, and mental well-being [43,44]. Therefore, it is necessary to design and implement prevention programs in order to reduce fear of COVID-19 and improve mental health.

It is notable that in our sample, individuals with a previous COVID-19 diagnosis had lower odds of acceptance of a second COVID-19 booster dose or a new COVID-19 vaccine than those without a previous COVID-19 diagnosis. Similar studies reveal that prior COVID-19 infection is associated with decreased intention to accept a COVID-19 vaccine [45] and reduced likelihood of a COVID-19 vaccine uptake [46]. Also, individuals with a previous COVID-19 diagnosis are more likely to be uncertain about accepting a COVID-19 vaccine [47]. Individuals who had previously been infected with COVID-19 and who are fully vaccinated with primer doses and the first booster may believe that they have immunity against the SARS-CoV-2.

Regarding socio-demographic factors, we found that younger participants were more likely to accept a second COVID-19 booster dose or a new COVID-19 vaccine than aged ones. Age is a controversial issue since some studies found that increased age is associated with increased acceptance of a first booster dose [16–18,20,22,24], while other studies found the opposite [15,21]. Low acceptance of a second COVID-19 booster dose or a new COVID-19 vaccine among aged persons would be of great concern since elderly is a high-risk group for COVID-19-related complications and mortality. On the other hand, low acceptance among younger persons is also of great importance since they are most likely to spread the SARS-CoV-2.

Our findings also indicated that males had higher odds of acceptance of a second COVID-19 booster dose or a new COVID-19 vaccine than females. Gender is also a complex issue since some studies found that males were more willing to accept a first booster [16,21], while other studies showed the opposite conclusion [17,20]. Low acceptance among females could be linked to psychological and hormonal gender differences [48,49].

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*Limitations*

We conducted a web-based survey that is easily susceptible to the effects of selection bias. In particular, aged persons were underrepresented in our study as confirmed by the age distribution of the participants. Median age of our sample was 37 years, while median age in Greece is 45.6 years [50]. Moreover, we expect that participation rate was higher among persons who are interested in health issues, such as vaccination and COVID-19 pandemic. Unfortunately, it was impossible to have data on non-participants in order to make valid comparisons with participants. Thus, we cannot confidently confirm our findings generalizability in other populations. In addition, we investigated several socio-demographic variables, COVID-19 related variables, and attitudes toward COVID-19 vaccination and pandemic as predictors of public willingness to receive a second COVID-19 booster dose or a new COVID-19 vaccine. However, there is still room for researchers to explore other predictors, e.g. income, occupation, media preferences, sources of information, knowledge level, etc. Although vaccination intentions tend to strongly predict actual behavior, actual uptake of a second COVID-19 booster dose or a new COVID-19 vaccine should be investigated in the future. Also, our findings reflect a snapshot of public willingness to accept a second COVID-19 booster dose or a new COVID-19 vaccine, but individual attitudes are dynamic and evolving. Thus, researchers should conduct longitudinal studies that measure changes in COVID-19 vaccination intentions over time. Self-reporting bias is always probable in studies with self-administrated questionnaires. In particular, willingness rate in our study may be an overestimation due to social desirability. Finally, we used an on-line questionnaire in Greek. Thus, only persons that understand the Greek language could participate in our study. In that case, participation rate of minority groups such as migrants is expected to be very low.

## 5. Conclusions

Our findings present important insights related to second COVID-19 booster dose or new COVID-19 vaccine willingness and potential factors related to booster/vaccine willingness. A significant proportion of those who have been vaccinated against COVID-19 with primer doses and a first booster dose reported the intention to accept a second COVID-19 booster dose or a new COVID-19 vaccine. This is very encouraging since booster shots or/and new COVID-19 vaccines will be essential in the control of the COVID-19 pandemic especially if new COVID-19 viral variants emerge. However, our results show some hesitancy and unwillingness toward further COVID-19 vaccination among those who are fully vaccinated against COVID-19. It is an urgent need to find solutions to change this attitude. For instance, identification of the potential predictors of COVID-19 vaccine willingness could prove essential in encouraging future uptake. Therefore, policy makers should develop public health interventions and effective communication strategies emphasizing the safety and the effectiveness of boosters in order to increase the COVID-19 vaccination uptake. Since evidence shows that existing COVID-19 vaccines offer protection for limited time periods, there is an urgent need to investigate ongoing attitudes of individuals toward boosters and new vaccines.

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