Original Article

Trust in Authorities and Demographic Factors Affect Vaccine Acceptance During the COVID-19 Pandemic in Cyprus

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Abstract: The COVID-19 pandemic has had a devastating impact on all aspects of human life. Accurately measuring vaccine acceptance and understanding the factors that influence vaccine attitudes and behaviors is crucial to designing public-health interventions to reduce the impact of COVID-19 through vaccinations. The current study adapted the vaccine acceptance scale (Sarathchandra et al., 2018) to the Greek language and assessed the relationship between key components of vaccine acceptance to COVID-19 vaccine beliefs and attitudes, personal and family vaccination history and attitudes, and demographic variables (age, sex, education, and having children). The adapted vaccine acceptance instrument was found to have high internal consistency reliability. Further analyses indicated that younger and less-educated individuals are more vaccine-hesitant, and that vaccine acceptance is influenced by trust in authorities. These findings may have implications for understanding vaccine hesitancy and for the design and implementation of vaccine-related public health policies.

Keywords: COVID-19, seasonal vaccine acceptance, vaccine hesitancy, public trust, online self-report survey

COVID-19 has caused a global crisis with devastating health, social, and economic impacts and more than 4 million confirmed deaths so far (https://covid19.who.int). In the following years, the World Health Organization (WHO) expects COVID-19 to continue to cause excess mortality, both because of deaths among those infected and because of healthcare systems being overwhelmed with COVID-19 patients or other patients' fear of becoming infected when visiting hospitals or their healthcare providers.

In Cyprus, despite drastic government measures to reduce the spread of the virus, including three lockdowns between March 2020 and May 2021, as of July 2021 the country has reported that more than 9% of its population was infected (80,529 cases), 5% of whom required hospitalization (4,002 cases), and 0.5% of whom (380 people) died.

Vaccinating the majority of the population is considered the single most important protective action in a community, a phenomenon described as herd immunity. Despite considerable evidence on the safety and effectiveness of available COVID-19 vaccines (Hernández et al., 2021), there is increasing hesitancy toward approved vaccines (Fridman et al., 2021; Larson et al., 2018; Lazarus et al., 2020, 2021; MacDonald et al., 2015). The WHO has identified vaccine hesitancy since 2019 as one of its top-ten global health threats (https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019).

Inconsistent government policy responses may represent important obstacles in reaching desirable vaccination numbers, although human factors such as beliefs and attitudes may also play an additional important role (Neumann-Böhme et al., 2020; Schoch-Spana et al., 2020). Reaching herd immunity requires understanding vaccine acceptance and the key factors contributing to it (Al-Mohaithef & Padhi, 2020).

Previous research identified a variety of factors that influence vaccine attitudes, the most important of which are demographic factors (Kohlhammer et al., 2007), lack of scientific understanding (Offit & Moser, 2011), and poor public trust in scientific and public institutions (Goldenberg, 2021). Indeed, an individual's attitudes toward vaccines touch upon complex trust relationships with public and scientific institutions, employers, and the pharmaceutical industry (De Figueiredo et al., 2020; Larson et al., 2018; Lazarus et al., 2020). Research on pediatric vaccine attitudes and more recent work on COVID-19 suggests that

motivators to vaccinate such as risk perception can vary by age, sex, and education, and heterogeneity in the relationship between these variables by country is substantial (Deml et al., 2019; Klein & Pekosz, 2014; Larson et al., 2018; Lazarus et al., 2020; MacDonald et al., 2015; Yaqub et al., 2014). For example, Lazarus et al. demonstrated that in Europe people younger than 50 are more vaccine-hesitant than older participants, whereas in China the opposite trend was displayed. These findings suggest the urgent need to develop reliable country-specific instruments to measure vaccine hesitancy and the contribution of demographics in vaccine hesitancy and attitudes.

To investigate vaccine acceptance in the Greek-speaking Cypriot population, the current study adapted an established vaccine acceptance instrument into Greek and investigated its internal consistency reliability (Sarathchandra et al., 2018). We also collected data on COVID-19 vaccine-related beliefs and attitudes during the pandemic in Cyprus and examined their relationship to key facets of vaccine acceptance as assessed by the adapted scale, personal and family attitudes and history, and demographic factors.

Table 1. Sample description

	Frequency (*N*)	% of total
Age		
Under 19	18	2.6%
20–29	244	34.8%
30–39	181	25.8%
40–49	176	25.1%
50–59	59	8.4%
Above 60	23	3.3%
Sex		
Female	401	57.2%
Male	300	42.8%
Highest educational degree		
Junior high school	5	0.7%
High school	98	14.0%
Bachelor's	267	38.1%
Master's	275	39.2%
PhD	56	8.0%
Children		
No	356	50.8%
Yes	345	49.2%

Methods

Procedure

The translated vaccine acceptance instrument was created and published as an online questionnaire on Esri's ArcGIS Survey123 platform and distributed widely via email and on social media (Facebook and Twitter) by the authors; 701 Greek-speaking residents of Cyprus completed it. The questionnaire was limited to allow only one submission per participant via the use of cookies or usernames. Answering all questions of the online questionnaire was required before submitting the questionnaire, which resulted in no missing data. Available data were analyzed using the Jamovi statistical package (The Jamovi Project, 2021).

The study was approved by the Cyprus National Bioethics Committee (2020/01/61). Data were collected between 31 March 2020 and 17 March 2021, whereas most data were collected before the approval of the first COVID-19 vaccine on 11 December 2020 (US Food and Drug Administration, 2020) and the vaccine rollout in Cyprus on 27 January 2021 (Cyprus Press and Information Office, 2021a). Specifically, 73.3% of the data were collected in April 2020, 0.3% in May 2020, 22.3% in November 2020, 0.4% in December 2020, 3.6% in January 2021, and 0.1% in February and March 2021.

The vaccine acceptance instrument was translated into Greek using the original vaccine acceptance instrument according to established translation protocols (Solano-Flores et al., 2009; Van de Vijver & Hambleton, 2006). Two bilingual academics, native Greek speakers (target language) and very fluent in English (source language), performed independent forward translations into the target language. The resulting preliminary version in Greek was next backtranslated into the original language (English) by another academic. The two English versions (i.e., the original and the backtranslated ones) were then compared and adjustments were made on any discrepancies. The translated vaccine acceptance instrument was then piloted on 10 individuals who provided feedback. The resulting final Greek version is presented in Supplementary Table 3.

Measures

Vaccine acceptance was measured using the vaccine acceptance instrument (Sarathchandra et al., 2018). It consists of 20 items scored on a 7-point Likert scale, as follows: 1 = *strongly disagree*, 2 = *moderately disagree*, 3 = *slightly disagree*, 4 = *I am unsure*, 5 = *slightly agree*, 6 = *moderately agree*, and 7 = *strongly agree*. The translated vaccine acceptance instrument is comprised of 5 subscales measuring key facets of vaccine acceptance that includes 4 items in each subscale: subscale 1, perceived safety of vaccines; subscale 2, perceived effectiveness and necessity of vaccines; subscale 3, acceptance of the selection and scheduling of vaccines; subscale 4, positive values and affect toward vaccines; subscale 5, perceived legitimacy of authorities to

Table 2. Descriptive statistics of the COVID-19 questions

	Finding a vaccine for the SARS-CoV-2 virus will stop the COVID-19 pandemic.	The SARS-CoV-2 vaccine should be available in all countries across the world.	The SARS-CoV-2 vaccine should be mandatory for anyone who can be vaccinated.	If a seasonal vaccine against the SARS-CoV-2 virus that causes COVID-19 is available, I will get it every year.	I changed my mind about vaccinations during this COVID-19 pandemic experience.
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Strongly disagree	48 (6.8)	24 (3.4)	106 (15.1)	86 (12.3)	216 (30.8)
Moderately disagree	24 (3.4)	5 (0.7)	47 (6.7)	36 (5.1)	41 (5.8)
Slightly disagree	42 (6.0)	16 (2.3)	50 (7.1)	64 (9.1)	239 (34.1)
I am not sure	161 (23.0)	53 (7.6)	97 (13.8)	182 (26)	99 (14.1)
Slightly agree	177 (25.2)	192 (27.4)	138 (19.7)	142 (20.3)	33 (4.7)
Moderately agree	91 (13.0)	39 (5.6)	85 (12.1)	61 (8.7)	59 (8.4)
Strongly agree	158 (22.5)	372 (53.1)	178 (25.4)	130 (18.5)	14 (2.0)
Median	5	7	5	4	3
Percentile 25	4	5	3	3	1
Percentile 75	6	7	7	6	4

require vaccinations. Twelve items (2, 3, 4, 5, 6, 11, 12, 13, 14, 16, 17, 18) are reversed so that higher scores indicate greater vaccine acceptance. Subscales are summed to derive separate totals for each subscale. Descriptive statistics of individual items and subscales are presented in Supplementary Table 1.

COVID-19 Vaccine Beliefs and Attitudes

Four questions assessed beliefs and attitudes about a COVID-19 vaccine and were scored on a 7-point Likert scale, similar to that above (Table 2). A reliability analysis indicated a Cronbach's $\alpha = 0.87$ of the summed score. However, to examine participants' attitudes separately for each question, we used the items individually in the analyses. An additional item assessed whether participants had changed their mind about vaccinations during the COVID-19 pandemic, also scored on a 7-point Likert scale. A summary of responses to the COVID-19 questions and descriptive statistics are presented in Table 2.

Personal and Family Vaccination History and Attitudes

Participants were asked whether they have been vaccinated with the flu vaccine (*Yes; No, it was my choice; No, it wasn't available; No, I just neglected to do it*). Participants who have children were asked to indicate whether they have vaccinated their children with the MMR vaccine (*Yes; No, it was my choice; No, but I will do it as soon as my child reaches the right age*) and the flu vaccine (*Yes; No, it was my choice; No, it wasn't available; No, I just neglected to do it*). Participants without children were asked if they would have chosen to vaccinate their children with the Flu and MMR vaccines if they had children (*Yes, No*).

Demographic Information

Through the online questionnaire we also collected demographic information such as age group (*< 19, 20–29, 30–39, 40–49, 50–59, > 60*), sex (*female, male, other*), highest educational degree (*Junior high school, High school, Bachelor's, Master's, Ph.D.*), and number of children (Table 1).

Results

Participants

In total, the sample participants were predominantly female (57.2%), between the ages of 20-50 (85.7%), most of whom (75.3%) had at least a Bachelor's degree. The demographics of the participants are presented in Table 1.

Comparison with Actual Vaccination Rates

As of this writing, the latest available figures indicate that 50.2% of the eligible population in Cyprus (i.e., > 16 years) have been fully vaccinated, and 64.6% of the eligible population has received at least the 1st dose (Cyprus Press and Information Office, 2021b). Those vaccination rates, together with the expected increased rates in the following weeks, compared to the 47.5% of the participants in our study who indicated their willingness to receive a seasonal COVID-19 vaccine, suggest an inconsistency that needs to be addressed.

First, we note that our study assessed willingness to receive a *seasonal vaccine* instead of a *one-off vaccination*

for COVID-19. We anticipate that the percentage of people willing to receive a seasonal vaccine is lower than those willing to receive a one-off vaccine. Second, note that we used a 7-point Likert scale, which allows people to indicate how sure or unsure they are about receiving a seasonal vaccine. As expected, some of the participants who indicate that they are unsure at the time of data collection might have later been convinced to proceed with vaccination, resulting in the expected increased vaccination rates. Third, an examination of our data in more detail by age group, while also considering the percentage of participants who indicate that they are unsure whether they are willing to receive a seasonal vaccine, shows that the results are more consistent with the actual vaccination rates (Supplementary Table 5).

Factor Analysis

The results of a principal components analysis (PCA) with Promax rotation on the 20 vaccine acceptance items indicate that all items except item 11 ("We give vaccines to children when they are too young") load on the same single component explaining 57% of the total variance.

However, given the conceptual justifications for distinguishing each of the dimensions of the instrument and previous research that employed these dimensions separately (Sarathchandra et al., 2018), we performed a confirmatory factor analysis using maximum likelihood and compared the fit of the single-factor model with the fit of the conceptually driven five-factor model. This analysis indicated a better fit for the 5-factor model ($\chi^2(142, N = 701) = 630$, $p < .001$, CFI = 0.95, TLI = 0.94, RMSEA = 0.07, upper RMSEA 90% CI = 0.08, AIC = 42557, BIC = 42862) compared to the single-factor model ($\chi^2(152, N = 701) = 1033$, $p < .001$, CFI = 0.91, TLI = 0.89, RMSEA = 0.09, upper RMSEA 90% CI = 0.1, AIC = 42940, BIC = 43199). Following these results, below we present the reliability indices of these five subscales. Next, we performed the rest of the analyses using the five subscales of the vaccine acceptance instrument.

Cronbach's α assessing the internal consistency reliability of the Greek translation of the vaccine acceptance instrument and each of the subscales indicated that the translated scale had an overall Cronbach's α = 0.95. The Cronbach's estimations for each of the subscales indicated for the perceived safety of vaccines α = 0.85, for the perceived effectiveness and necessity of vaccines subscales α = 0.79, for the acceptance of the selection and scheduling of vaccines subscale α = 0.46 (removing item 11 resulted in α = 0.80, therefore, item 11 was removed from all subsequent analyses); for the positive values and affect toward vaccines subscale α = 0.91; for the perceived legitimacy of authorities to require vaccinations subscale α = 0.89. After removing item 11, Cronbach's α for the remaining 19 items was estimated at 0.96.

Pearson product-moment correlation coefficients indicated high latent correlations among the five subscales that ranged between .67 and .81 (Supplementary Table 4) indicating strong convergent validity.

Variables Predicting COVID-19 Vaccine Beliefs and Attitudes

First, we employed hierarchical multiple linear regression to examine the relationship between each of the five COVID-19 vaccine beliefs and attitudes items to demographics, the five factors of the vaccine acceptance instrument, and the personal and family vaccination history and attitudes questions (comprised in a single variable as the sum, using *Yes* = 1 and all types of *No* = 0; see Supplementary Table 2). The regression models were run in three steps with each of the COVID-19 vaccine beliefs and attitudes items as the dependent variables. First, we entered the demographic variables into the model as independent variables (age, sex, education, children). Second, the five factors of the vaccine acceptance instrument were added to the model as independent variables. Third, the personal and family vaccination history and attitudes sum was added into the model. Standardized regression coefficients for each independent variable and model fit parameters were estimated at each step. Multicollinearity was assessed using variance inflation analysis (VIF), assuming no collinearity for values below 10.

Model fit parameters are presented in Table 3. The results indicate that, for COVID-19 vaccine beliefs and attitudes items 1 and 2, model 2 provided the best fit (i.e., model 3 did not improve the fit), and for items 3, 4, and 5, model 3 provided the best fit (a better fit was indicated by higher R^2 and adjusted R^2 values, and by lower AIC, BIC values, and RMSE values). Table 4 presents the standardized coefficients as well as the adjusted R^2 and R^2 values of the best fit model for each of the items, demonstrating high R^2 values of the best fit model for items 1, 2, 3, and 4, ranging between .49 and .59, whereas R^2 for item 5 was very low (.12). Moreover, these results indicate that "Perceived legitimacy of authorities to require vaccinations" is the strongest predictor of items 1, 3, and 4, "Positive values and affect toward vaccines" is the strongest predictor of items 2, and "Education" is the strongest predictor of item 5.

These results indicate that perceived safety, perceived effectiveness and necessity, positive values, perceived legitimacy of authorities to require vaccinations, and age, have a positive influence on the belief that a COVID-19 vaccine will end the pandemic (item 1). Perceived safety, perceived effectiveness, positive values, and perceived

Table 3. Model fit parameters for COVID-19 vaccine beliefs and attitudes

Dependent variable	R^2	Adjusted R^2	AIC	BIC	RMSE
I believe that finding a vaccine for the SARS-CoV-2 virus will stop the COVID-19 pandemic.					
Model 1	0.06	0.05	2704	2731	1.65
Model 2	0.50	0.49	2273	2323	1.20
Model 3	0.50	0.49	2275	2329	1.20
I believe that the SARS-CoV-2 vaccine should be available in all countries across the world.					
Model 1	0.04	0.04	2539	2567	1.47
Model 2	0.49	0.49	2107	2157	1.07
Model 3	0.49	0.49	2107	2162	1.07
I believe that the SARS-CoV-2 vaccine should be mandatory for anyone who can be vaccinated.					
Model 1	0.07	0.06	2986	3013	2.02
Model 2	0.58	0.57	2441	2491	1.36
Model 3	0.59	0.58	2426	2481	1.34
If a seasonal vaccine against the SARS-CoV-2 virus that causes COVID-19 is available, I will get it every year.					
Model 1	0.08	0.07	2821	2848	1.79
Model 2	0.54	0.54	2335	2385	1.26
Model 3	0.57	0.57	2291	2346	1.22
I changed my mind about vaccinations during this COVID-19 pandemic experience.					
Model 1	0.08	0.08	2634	2661	1.57
Model 2	0.12	0.11	2617	2667	1.54
Model 3	0.12	0.11	2614	2669	1.53

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; RMSE = root mean square error.

legitimacy of authorities to require vaccinations have a positive effect on the belief that a COVID-19 vaccine should be made available to all countries (item 2). Perceived effectiveness, acceptance of selection and scheduling, perceived legitimacy of authorities, and personal and family vaccination history have a positive influence on the belief that a COVID-19 vaccine should be made mandatory to everyone, whereas having children had a significant negative influence on this item (item 3). Perceived effectiveness, acceptance of selection and scheduling, perceived legitimacy of authorities, personal and family vaccination history, and age, have a positive influence on the desire to get vaccinated with a seasonal COVID-19 vaccine (item 4). Perceived safety had a negative influence on the change of mind (item 5; i.e., people with higher vaccine safety perceptions were less likely to change their mind), men and people with higher education were less likely to have changed their minds, whereas people with higher scores on personal and family vaccination history and attitudes were more likely to have changed their mind during the pandemic.

Effects of Demographic Variables on Vaccine Acceptance

We performed a one-way analysis of variance (Welch's ANOVA) to examine the effects of the demographic variables age, sex, education, and children on the five subscales of the vaccine acceptance instrument, on the COVID-19 vaccine beliefs and attitudes items, and on the personal and family vaccination history and attitudes sum. Table 5 presents results that passed the strict α-level of .001 to account for multiple comparisons.

Results indicated that age had a main effect on vaccine acceptance subscales 2 (effectiveness and necessity), 4 (positive values and affect), and 5 (legitimacy of authorities), on COVID beliefs and attitudes item 1 (vaccine will end pandemic), item 3 (vaccine should be mandatory), and item 4 (willingness to get a seasonal vaccine), and on personal and family vaccination history and attitudes. Post-hoc analyses (using Games-Howell criterion and $\alpha = < .001$) indicated that the 20s age group responded significantly lower (i.e., lower values across all items represent lower vaccine acceptance) than those in their 30s and 40s on all subscales and items with significant main effects. A similar trend of lower vaccine acceptance in the 20s group compared to the 50s and 60s group was also observed (see Table 5), but these comparisons did not reach statistical significance. To further explore the relationship between age and vaccine acceptance, we performed a Pearson correlation analysis between age group and the five vaccine acceptance subscales, the COVID-19 vaccine beliefs and attitudes items, and the personal and family vaccination history and attitudes factor, controlling for education, sex, and children. Results that passed the .001 alpha criterion indicated a small but significant positive correlation between age and COVID-19 item 1,

Table 4. Standardized coefficients (CI LL, CI UL) from multiple linear regression models explaining COVID-19 vaccine beliefs and attitudes

Predictors	I believe that finding a vaccine for the SARS-CoV-2 virus will stop the COVID-19 pandemic.	I believe that the SARS-CoV-2 vaccine should be available in all countries across the world.	I believe that the SARS-CoV-2 vaccine should be mandatory for anyone who can be vaccinated.	If a seasonal vaccine against the SARS-CoV-2 virus that causes COVID-19 is available, I will get it every year.	I changed my mind about vaccinations during this COVID-19 pandemic experience.
Perceived safety of vaccines	0.12* (.02, .22)	0.12* (.02, .22)	0.05 (−.04, .14)	0.08 (−.01, .18)	−0.16* (−.29, −.02)
Perceived effectiveness and necessity of vaccines	0.17*** (.07, .26)	0.21*** (.12, .31)	0.12** (.04, .21)	0.20*** (.12, .29)	−0.07 (−.19, .06)
Acceptance of the selection and scheduling of vaccines	0.07 (−.01, .15)	0.03 (−.5, .12)	0.08* (.01, .16)	0.08* (.0, .15)	0.02 (−.09, .13)
Positive values and affect toward vaccines	0.18** (.07, .29)	0.30*** (.19, .42)	−0.06 (−.16, .04)	0.01 (−.09, .11)	−0.02 (−.16, .13)
Perceived legitimacy of authorities to require vaccinations	0.23*** (.14, .33)	0.10* (0, .19)	0.55*** (.46, .63)	0.30*** (.22, .39)	−0.04 (−.17, .09)
Personal and family vaccination history and attitudes			0.13*** (.07, .19)	0.21*** (.15, .28)	0.10* (.01, .19)
Age	0.09* (.02, .17)	0.00 (−.07, .07)	0.06 (−.01, .13)	0.10* (.04, .17)	0.02 (−.08, .12)
Sex	0.02 (−.04, .07)	0.00 (−.06, .05)	0.01 (−.04, .06)	0.03 (−.02, .08)	−0.14*** (−.21, −.06)
Education	0.00 (−.06, .06)	0.01 (−.05, .07)	0.02 (−.04, .07)	0.01 (−.04, .07)	−0.21*** (−.29, −.14)
Have children	−0.08 (−.15, −.01)	0.00 (−.07, .07)	−0.08* (−.15, −.01)	−0.06 (−.13, .01)	−0.04 (−.14, .06)
Adjusted R^2	0.49	0.49	0.58	0.57	0.11
R^2	0.50	0.49	0.59	0.57	0.12

Note. Cronbach's α for each vaccine acceptance factor is displayed in parenthesis. CI = confidence interval; LL = lower limit; UL = upper limit. *$p < .05$, **$p < .01$, ***$p < .001$.

Table 5. Means, standard deviations, and analyses of variance results of significant effects ($\alpha < .001$) in the five subscales of the Vaccine Acceptance Scale, questions examining COVID-19 vaccine beliefs and attitudes, and personal and family history and attitudes

	Age: Means (*SD*)							
Measure	< 19	20–29	30–39	40–49	50–59	> 60	*F* (*df*1, *df*2)	η_p^2
VA subscales								
Subscale 2	18.94 (4.84)	18.61 (4.86)	20.93 (5.01)	20.89 (5.23)	20.12 (5.41)	21.13 (5.17)	6.49 (5, 96.6)	0.25
Subscale 4	20.00 (6.53)	21.21 (6.04)	23.60 (5.73)	23.44 (5.77)	22.34 (5.58)	24.04 (4.71)	5.31 (5, 97.3)	0.21
Subscale 5	16.50 (6.63)	17.49 (6.64)	20.50 (6.38)	21.09 (6.60)	19.63 (7.03)	22.00 (5.50)	8.83 (5, 97.2)	0.31
COVID beliefs-attitudes								
Item 1	4.50 (1.15)	4.40 (1.80)	5.12 (1.64)	5.11 (1.57)	5.19 (1.48)	5.09 (1.93)	5.83 (5, 98.7)	0.23
Item 3	4.33 (1.75)	3.95 (2.23)	4.86 (1.98)	4.84 (1.97)	4.90 (2.05)	5.04 (1.46)	5.95 (5, 99.3)	0.23
Item 4	3.89 (0.96)	3.80 (1.88)	4.55 (1.87)	4.81 (1.69)	4.83 (1.95)	4.87 (1.89)	8.89 (5, 101.3)	0.30
Personal history	2.15 (0.51)	1.94 (0.58)	2.21 (0.77)	2.22 (0.73)	2.29 (0.74)	2.35 (0.71)	6.57 (5, 97.2)	0.25

	Sex: Means (*SD*)			
	Female	Male	*F*(*df*1, *df*2)	η_p^2
VA subscales				
Subscale 5	20.26 (6.23)	18.43 (7.26)	12.29 (1, 586)	0.21

	Education: Means (*SD*)						
	Junior high	High school	Bachelor's	Master's	PhD	*F*(*df*1, *df*2)	η_p^2
VA subscales							
Subscale 1	15.40 (4.72)	18.44 (5.70)	19.67 (4.79)	20.89 (5.19)	22.75 (5.71)	7.89 (4, 29.4)	0.52
Subscale 2	14.20 (5.85)	18.36 (5.51)	19.24 (4.97)	20.99 (4.83)	22.16 (5.03)	9.70 (4, 29.2)	0.57
Subscale 4	16.00 (6.82)	19.97 (6.87)	21.90 (5.63)	23.83 (5.34)	24.41 (5.96)	9.99 (4, 29.2)	0.58
Subscale 5	11.60 (7.44)	16.11 (7.44)	18.60 (6.48)	21.09 (6.06)	22.30 (6.37)	14.08 (4, 29.2)	0.66
COVID beliefs-attitudes							
Item 1	3.80 (2.28)	4.47 (1.75)	4.55 (1.67)	5.22 (1.61)	5.27 (1.71)	7.41 (4, 29.2)	0.50
Item 2	4.80 (2.49)	5.18 (1.82)	5.76 (1.50)	6.13 (1.28)	6.00 (1.46)	6.59 (4, 29)	0.48
Item 3	3.20 (2.05)	3.93 (2.23)	4.15 (2.11)	5.03 (1.89)	5.20 (2.03)	9.86 (4, 29.3)	0.57
Item 4	3.20 (2.49)	3.84 (1.78)	4.10 (1.88)	4.66 (1.74)	5.25 (1.99)	7.92 (4, 29.2)	0.52
Item 5	5.40 (1.52)	3.33 (1.67)	3.17 (1.67)	2.63 (1.55)	1.91 (1.03)	19.30 (4, 29.6)	0.72
Personal history	1.73 (0.15)	2.02 (0.64)	2.07 (0.67)	2.18 (0.73)	2.39 (0.77)	10.11 (4, 37.3)	0.52

	Children: Means (*SD*)			
	No	Yes	*F* (*df*1, *df*2)	η_p^2
VA subscales				
Subscale 2	19.33 (5.13)	20.69 (5.08)	12.40 (1, 699)	0.02
Subscale 4	21.78 (6.27)	23.34 (5.45)	12.41 (1, 691)	0.02
Subscale 5	18.46 (6.59)	20.52 (6.75)	16.85 (1, 697)	0.02
COVID beliefs-attitudes				
Item 4	4.06 (1.88)	4.70 (1.80)	21.16 (1, 699)	0.03

Note. VA = vaccine acceptance. Subscale 1, Safety; Subscale 2, Effectiveness and necessity; Subscale 3, Selection and scheduling; Subscale 4, Positive values and affect; Subscale 5, Legitimacy of authorities; COVID beliefs-attitudes items: Item 1 – I believe that finding a vaccine for the SARS-CoV-2 virus will stop the COVID-19 pandemic. Item 2 – I believe that the SARS-CoV-2 vaccine should be available in all countries across the world. Item 3 – I believe that the SARS-CoV-2 vaccine should be mandatory for anyone who can be vaccinated. Item 4 – If a seasonal vaccine against the SARS-CoV-2 virus that causes COVID-19 is available, I will get it every year. Item 5 – I changed my mind about vaccinations during this COVID-19 pandemic experience.

suggesting that older participants are more likely to believe that a vaccine will end the pandemic ($r(701) = .13$, $p < .001$).

Analysis of variance found a significant main effect of sex on vaccine acceptance subscale 5, indicating that females responded higher than males (i.e., greater vaccine acceptance) on perceived legitimacy of authorities to require vaccinations.

Education had a significant main effect on all vaccine acceptance subscales except on subscale 3 (selection and scheduling), on all COVID beliefs and attitudes items, and on the personal and family vaccination history and attitudes factor, indicating higher vaccine acceptance with higher educational levels (Table 5). Similar post-hoc analyses to those reported above indicated significant educational effects, particularly between participants with

a high school and Bachelor's degree and those with Master's and Ph.D. degrees. However, more informative to our goal of understanding the relationship between education and vaccine acceptance is the Pearson partial-correlation analysis we performed between educational level and the rest of the variables, controlling for age, sex, and children. This analysis suggested that a higher educational level correlates with a higher vaccine acceptance as indicated by the significant positive correlations between educational level and vaccine acceptance subscale 1 ($r(701) = .20$, $p < .001$), subscale 2 ($r(701) = .20$, $p < .001$), subscale 4 ($r(701) = .22$, $p < .001$), subscale 5 ($r(701) = .25$, $p < .001$), COVID beliefs and attitudes item 1 ($r(701) = .16$, $p < .001$), item 2 ($r(701) = .17$, $p < .001$), item 3 ($r(701) = .19$, $p < .001$), item 4 ($r(701) = .17$, $p < .001$), and item 5 ($r(701) = .26$, $p < .001$). Taken together, these results suggest that education plays a significant role in vaccine acceptance, independent of other factors such as age, sex, and being a parent.

Being a parent was also found to have significant main effects on vaccine acceptance subscales 2 (effectiveness and necessity), 4 (positive values and affect), and 5 (legitimacy of authorities), and on COVID beliefs and attitudes item 4 (willingness to take a seasonal vaccine). Post-hoc analyses like those reported above indicated that participants with children had significantly higher vaccine acceptance on all significant effects.

Discussion

In the current study, the vaccine acceptance instrument was translated and adapted to Greek showing good internal consistency. Reliability estimates indicated that each factor of the Greek version has a high internal consistency reliability (Cronbach's α) of 0.79–0.91, which is comparable to the originally published instrument (Sarathchandra et al., 2018). Item 11 ("We give vaccines to children when they are too young") did not load well on either the single-factor model (with 95% of the variance "unique" to the item and not explained by the factor) or on the "acceptance of the selection and scheduling of vaccines" subscale (86% of variance unique to the item). Sarathchandra et al. (2018) reported a high Cronbach's α = 0.89 for the acceptance of the selection and scheduling of vaccines subscale, and in the original version item 11 had a high factor loading of 0.801 (reported in supplementary Table 6 of Sarathchandra et al., 2018). This suggests that the translation of the item into Greek might have led to an ambivalence as to whether the question suggests that children are wrongfully too young or that they are rightfully young enough. Future research may attempt to modify this item for inclusion in the relevant subscale. Taken together, these results suggest that the Greek version of the vaccine acceptance instrument has good internal consistency reliability and may be utilized for future research in Greek-speaking populations in several ways, such as understanding of how vaccine acceptance changes over time (Fridman et al., 2021) or in response to public health interventions and its relationship to public trust in health and government institutions (Goldenberg, 2016; Larson et al., 2018).

Furthermore, we investigated the potential acceptance of a COVID-19 vaccine during the pandemic in a Greek-speaking population in Cyprus. Approximately half (47.5%) responded that they are willing to take a seasonal COVID-19 vaccine, and more than half believe that a vaccine will stop the pandemic and it should be mandatory (60.7% and 57.2%, respectively), whereas the majority think that the vaccine should be made available to all countries and haven't changed their mind about the vaccines during the pandemic (86.1% and 84.9%, respectively). These vaccine acceptance proportions are on the low end of recent international estimates (Lazarus et al., 2021), and although they present a particular concern for Cypriot authorities in light of the latest estimates indicating that herd immunity requires vaccinating the majority of the total population (Anderson et al., 2020; Neagu, 2020), actual vaccination numbers indicate that individuals who reported being unsure about receiving a seasonal COVID-19 vaccine may have been open to receiving a vaccine during the pandemic, indicating that they may have changed their attitudes in recent months.

Our findings indicate that demographic factors, overall vaccine perceptions and attitudes as well as personal and family history and attitudes are all important factors that may influence vaccine acceptance during a pandemic. A major finding is the significant differences between vaccine acceptance of the various age and educational groups, which is consistent with recent international estimates from European countries (Lazarus et al., 2020). Specifically, participants in their 20s were significantly more hesitant than older participants. Moreover, people with postgraduate degrees were found to be more vaccine receptive, and correlation analyses indicated that a higher educational level indicates a higher vaccine acceptance. Although on the face of it, these findings may indicate that scientific literacy by people with a lower educational level or vaccine motivational factors such as risk aversion (Turner & McClure, 2003) and perceptions of individual (as opposed to communal) risk (Franzen & Wöhner, 2021) are the driving forces behind vaccine acceptance (Offit & Moser, 2011), it is unclear whether these differences reflect these factors or whether they instead reflect poor public trust in scientific institutions by younger and less well-educated participants (Goldenberg, 2021).

For example, a focus on the factors affecting willingness to get a seasonal COVID-19 vaccine suggests that trust is

indeed a central issue in understanding vaccine hesitancy. Specifically, perceived vaccine safety had no effect and perceived effectiveness had a moderate effect, whereas the strongest effect was perceived legitimacy of authorities to require vaccinations (Table 3). In other words, understanding the science of vaccine safety and effectiveness did not have as strong a relationship with willingness to get a seasonal vaccine as did trusting authorities. This finding may also help to explain the age and educational findings, suggesting that older and better-educated people are indeed more likely to trust science and government institutions (Foster & Frieden, 2017).

Moreover, perceived safety of vaccines did not add significantly to the belief that the vaccine should be made mandatory and had only a small effect on the belief that the vaccine can end the pandemic. However, perceived legitimacy of authorities to require vaccinations had the strongest contribution in the belief that the vaccine will end the pandemic and that it should be made mandatory, supporting the suggestion that vaccine hesitancy is a problem of public trust in authorities (Goldenberg, 2016). This finding suggests that vaccine hesitancy may be a problem of trust resulting in rejecting the legitimacy of the scientific consensus articulated by public and scientific institutions for guiding public opinion and actions, and may have important implications regarding public health policies aiming to increase vaccinations. For example, governments, public health agencies, scientific institutions, and pharmaceutical companies should focus on designing interventions that respond to factors influencing public trust, such as reducing discrimination, reducing susceptibility to industry influence through transparency, and improving public health messaging by avoiding shaming and blaming the public and instead encouraging community values and priorities. Moreover, the level of trust in interpersonal relationships, as opposed to relationships at the institutional level described above, such as between individuals and their healthcare provider, might also be important to consider (e.g., building channels that provide accurate scientific information about vaccine safety and efficacy to healthcare providers, and training healthcare providers in clinical communication skills) when designing interventions for improving vaccination rates.

The study had limitations, such as the fact that the mode of data collection did not ensure a representative sample, which limits the generalizability of the findings. The data were collected during a highly dynamic and changing environment, and the data-collection period was long, which may have affected people's beliefs and attitudes toward vaccinations. Further, self-reported data may result in information bias, and sample selection bias might have resulted because of the way the online questionnaire was circulated. Future work should address these limitations and test directly whether vaccine acceptance is affected by lack or misunderstanding of the underlying science or by public trust in scientific institutions and authorities.

In conclusion, the current study demonstrated the high reliability of the five-factor vaccine acceptance instrument in Greek. By investigating the relationship between key facets of vaccine acceptance, demographic factors, and personal history, the study provides preliminary findings suggesting that an effective COVID-19 immunization plan should target younger and less well-educated individuals. When designing public interventions, policymakers should consider the issue of public trust in scientific and public institutions and focus on the pool of individuals who remain unsure as a target group about changing their beliefs and attitudes toward vaccinations.

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Open Materials: We confirm that there is sufficient information for an independent researcher to reproduce all of the reported methodology (Konstantinou et al., 2021).

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