

Table 1 Descriptive statistics of the main variables used in the model

	Round 2		Round 3		P value χ^2 test for differences between rounds)
	Number	%	Number	%	
Sex					
Male	5263	50.32	5501	50.32	<0.0001
Female	5197	49.68	5431	49.68	
Age (years)					
18–24	2292	21.91	2395	21.91	<0.0001
25–34	2743	26.22	2866	26.22	0.15
35–49	2926	27.97	3058	27.97	<0.0001
50+	2500	23.90	2612	23.90	<0.0001
Occupation					
Education	562	5.39	604	5.56	<0.0001
Health worker	459	4.40	746	6.86	
Homemaker	2242	21.50	3805	34.99	
Not currently in paid work	2033	19.50	1198	11.01	
Other essential services	4113	39.44	3266	30.03	
Student	1019	9.77	1256	11.55	
Comorbidity					
Yes	1804	17.30	1860	17.05	<0.0001
No	8625	82.70	9048	82.95	
Previous COVID-19 infection					
Yes	1874	18.24	2338	21.68	<0.0001
No	8402	81.76	8444	78.32	
Knowledge about COVID-19 transmission					
Yes	6823	69.95	6887	67.85	0.648
No	2931	30.05	3264	32.15	
COVID-19 risk perception					
Very likely/likely	2900	30.17	2793	27.08	<0.0001
Neutral	1697	17.65	1977	19.17	
Unlikely/very unlikely	5017	52.18	5543	53.75	
Trust in local healthcare provider					
Extremely/very much	5270	51.76	5131	48.14	<0.0001
Moderately	2727	26.78	2942	27.60	
Slightly/not at all	2184	21.45	2586	24.26	
Trust in vaccine effectiveness					
Extremely/very much	4673	50.17	4376	44.06	<0.0001
Neutral	2709	29.09	3094	31.16	
Slightly/not at all	1932	20.74	2461	24.78	
Believes that vaccines offer protection					
Extremely/very much	5331	54.60	4207	40.39	<0.0001
Neutral	2798	28.66	4275	41.05	
Slightly/not at all	1635	16.74	1933	18.56	
Believes in the safety of the vaccines					
Extremely/very much	5076	52.18	4727	45.63	<0.0001
Neutral	2936	30.18	3411	32.93	
Slightly/not at all	1716	17.64	2221	21.44	
Believes in serious side effects associated with COVID-19					
Extremely/very much	1806	19.07	2843	27.88	<0.0001
Neutral	2141	22.61	1551	15.21	
Slightly/not at all	5520	58.31	5805	56.91	

Table 1 Descriptive statistics of the main variables used in the model (concluded)

	Round 2		Round 3		P value χ^2 test for differences between rounds)
	Number	%	Number	%	
Believes in severity of COVID-19 infection					
Extremely/very much	3051	32.63	3265	32.43	<0.0001
Neutral	2355	25.19	2523	25.06	
Slightly/not at all	3944	42.18	4280	42.51	
Vaccination status					
Vaccinated	6371	60.91	8548	78.35	<0.0001
Not vaccinated but willing	2612	24.98	1231	11.28	<0.0001
Not vaccinated and undecided	481	4.60	199	1.83	<0.0001
Not vaccinated and not willing	995	9.52	932	8.54	0.046

with younger women aged 18–24 years, older women and men were less willing to be vaccinated. Compared with younger women aged 18–24 years, younger and older men were less likely to be undecided regarding vaccination. The age/sex variable had lower explanatory power when describing those unwilling to be vaccinated. The findings were broadly consistent when repeated on the subgroups of low- and middle-income countries. Importantly, the interaction between age and sex did affect the robustness of the rest of the findings reported above. As an additional check of robustness, we conducted a polynomial logit modelling analysis, whose findings were consistent with the above analysis.

Discussion

To our knowledge, this is the first comprehensive analysis of the main correlates of COVID-19 vaccination status in the EMR, with consideration of 4 vaccination categories. We analysed the correlates of vaccination status over time, the link between vaccination status and vaccine availability, and the vaccination categories according to economic development.

The findings suggest that, despite efforts to increase vaccination coverage across the EMR, about 1 in 10 respondents was unwilling to be vaccinated, and the number unwilling to be vaccinated remained stable between the 2 survey rounds. There is mixed evidence to date regarding the extent of COVID-19 vaccination hesitancy in the general population and how it has evolved over time. A study in the United States of America (USA) found an increase in the number of respondents unwilling to be vaccinated (30). However, the results of those studies could simply be a reflection of the sampling/data collection methods; or more specifically, the datasets were not representative of the population that they aimed to study. Our study used a regionally representative sample and is believed to be the first to suggest that there was a small but persistent group of vaccine refusers, whose unwillingness to be vaccinated did not change over time. The characteristics of these individuals were distinct from those of individuals in the other vaccination categories, suggesting that different

strategies will be required for this group. Further research is needed to better understand these implications

We found that some demographic characteristics were associated with vaccination status. In particular and given the priorities of the vaccination drives, older individuals were more likely to be vaccinated. Women were more likely than men to be undecided about whether to be vaccinated. Younger (aged 18–24 years) compared with older individuals were more unwilling to be vaccinated. In the USA, it was shown that a higher likelihood of vaccination was associated with male sex, older age, and higher educational level (31). There is evidence of a link between vaccination status and socioeconomic characteristics in the EMR. A study in the Gaza Strip, for example, found that males and older people had higher odds of being vaccinated against COVID-19 (19), and similar findings emerged from a survey in Jordan (17).

Beliefs about the COVID-19 vaccines were significantly associated with the probability of being vaccinated, willingness to be vaccinated, and unwillingness to be vaccinated. More specifically, positive beliefs about safety, effectiveness, and adverse effects of COVID-19 vaccines were associated with increased odds of being vaccinated or willingness to be vaccinated. By contrast, negative beliefs about COVID-19 vaccines increased the probability of unwillingness to be vaccinated. The findings for the 4 vaccination categories were consistent across the 2 subgroups of low- and middle-income countries.

A large body of evidence from the EMR has also documented the link between vaccination status and beliefs about vaccines. A study among healthcare workers in Egypt found that the reasons for vaccine acceptance revolved around safety and effectiveness, while fear of adverse effects was the main reason for vaccine hesitancy. More specifically, misinformation about fertility was of greater concern among women than men in studies in the EMR (32, 33). Concerns about safety as well as general lack of trust in the vaccines were the main reasons for vaccine hesitancy among healthcare workers in Sudan and Iraq (7, 13). Lack of trust in vaccine effectiveness and