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Predictors and barriers to vaccination among older Syrian refugees in Lebanon: a cross-sectional analysis of a multi-wave longitudinal study

Berthe Abi Zeid, Tanya El Khoury*, Hala Ghattas, Marwan F Alawieh, Zeinab Ramadan, Sirine Anouti, Sawsan Abdulrahim†, Stephen J McCall†*

Summary

Background Vaccination is important to prevent morbidity and mortality due to COVID-19 among older Syrian refugees. We aimed to elucidate the predictors of COVID-19 vaccine uptake among Syrian refugees aged 50 years or older in Lebanon and to understand their main reasons for not receiving the vaccine.

Methods This was a cross-sectional analysis of a five-wave longitudinal study, conducted through telephone interviews between Sept 22, 2020, and March 14, 2022, in Lebanon. For this analysis, data were extracted from wave 3 (Jan 21–April 23, 2021), which included a question on vaccine safety and on whether participants intended to receive the COVID-19 vaccine, and wave 5 (Jan 14–March 14, 2022), which included questions on actual vaccine uptake. Syrian refugees aged 50 years or older were invited to participate from a list of households that received assistance from the Norwegian Refugee Council, a humanitarian non-governmental organisation. The outcome was self-reported COVID-19 vaccination status. Multivariable logistic regression was used to identify predictors of vaccination uptake. Validation was completed internally with bootstrapping methods.

Findings 2906 participants completed both wave 3 and 5; the median age was 58 (IQR 55–64) years and 1538 (52·9%) were male. 1235 (42·5%) of 2906 participants had received at least one dose of the COVID-19 vaccine. The main reasons for not receiving the first dose included being afraid of its side-effects (670 [40·1%] of 1671) or not wanting the vaccine (637 [38·1%] of 1671). 806 (27·7%) of 2906 participants received the second dose of the vaccine and 26 (0·9%) of 2906 received the third dose. The main reason for not receiving the second (288 [67·1%] of 429) or third dose (573 [73·5%] of 780) was waiting for a text message for an appointment. Predictors of receiving at least one dose of the COVID-19 vaccine included younger age (odds ratio 0·97; 95% CI 0·96–0·98), being male (1·39; 1·19–1·62), living inside informal tented settlements (1·44; 1·24–1·66), having elementary (1·23; 1·03–1·48) and preparatory education or above (1·15; 0·95–1·40), and having a pre-existing intention to receive the vaccine (1·29; 1·10–1·50). After adjusting for optimisation, the final model, which includes these five predictors of receiving at least one dose of the COVID-19 vaccine, showed moderate discrimination (C-statistic 0·605; 95% CI 0·584–0·624) and good calibration (c-slope 0·912; 95% CI 0·758–1·079).

Interpretation There is an ongoing need to address COVID-19 vaccine uptake among older Syrian refugees by improving deployment planning and raising awareness about the importance of vaccination.

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*Joint first authors

†Senior authors

Center for Research on Population and Health, Faculty of Health Sciences, American University of Beirut, Beirut, Lebanon (B Abi Zeid MPH, T El Khoury MPH, H Ghattas PhD, S J McCall DPhil); **Norwegian Refugee Council, Beirut, Lebanon** (M F Alawieh MPH, Z Ramadan BS, S Anouti MPH); **Department of Health Promotion and Community Health, Faculty of Health Sciences, American University of Beirut, Beirut, Lebanon** (S Abdulrahim PhD)

Correspondence to:
Dr Stephen J McCall, Center for Research on Population and Health, Faculty of Health Sciences, American University of Beirut, Beirut 1107 2020, Lebanon
sm227@aub.edu.lb

Introduction

Vaccination against COVID-19 is crucial for mitigating the impact of the pandemic.[1] As of March 31, 2023, around 69·8% of the world population had received at least one dose of the COVID-19 vaccine.[2] Yet, in low-income countries, only 28·7% of people have received at least one dose.[2] Although inequalities in the distribution of the COVID-19 vaccine between and within countries have been widely reported,[3] disparities in vaccine intention remain a key obstacle globally. For example, vaccine acceptance rates vary between 97% in Nepal and Viet Nam and 13% in Iraq.[4]

Most research worldwide has focused on the intention to receive the COVID-19 vaccine rather than actual vaccine uptake.[5–10] According to a systematic review of international studies, predictors of COVID-19 vaccine uptake included sex, age, being native born rather than an immigrant or refugee, and educational and economic status.[1] Potential barriers to COVID-19 vaccine acceptance among refugees worldwide could be related to cultural and religious beliefs, mistrust in the health system, lack of knowledge and awareness about the importance of vaccination, lack of access to vaccination centres, and lack of required documentation for vaccine registration.[11]

Lebanon hosts approximately 1·5 million Syrian refugees, including 831 053 registered with the UN High Commissioner for Refugees (UNHCR).[12] Given the country's stretched health-care system, Syrian refugees

Research in context

Evidence before this study

We searched PubMed and Google Scholar for studies published between Feb 1, 2020, and Sep 29, 2022, focusing on COVID-19 vaccine intention and uptake among older Syrian refugees. We used the following combinations of keywords in our search: "COVID-19 vaccine hesitancy", "COVID-19 vaccine uptake", "vaccine literacy", "vaccine acceptance", "Syrian refugees", "predictors", and "education". Previous evidence has shown that Syrian refugees have a high risk of severe morbidity and death from COVID-19. Vaccine intention among this vulnerable group in Lebanon is low, and there is a paucity of data available about vaccine uptake in refugee populations. Additionally, older Syrian refugees have faced multiple barriers to accessing health care. Hence, measuring actual COVID-19 vaccine uptake and understanding the predictors influencing vaccine uptake among older Syrian refugees is crucial to improving vaccination access and strategies related to COVID-19 in Lebanon.

Added value of this study

To the best of our knowledge, no studies have examined predictors of COVID-19 vaccine uptake and measured the rate of vaccination among older Syrian refugees. In this cross-sectional analysis of a multi-wave longitudinal study, 1235 (42·5%) of 2906 participants received at least one dose of COVID-19 vaccine, and 806 (27·7%) received two doses of COVID-19 vaccine. Additionally, this study developed a predictive model and identified five predictors of receiving at least one dose of the COVID-19 vaccine among older Syrian refugees: younger age, being male, living inside informal tented settlements, having elementary and preparatory education or above, and having a pre-existing intention to receive the COVID-19 vaccine.

Implications of all the available evidence

These findings suggest an ongoing need to address vaccine acceptance and uptake among older Syrian refugees by spreading awareness about the importance of vaccination against COVID-19 and enhancing the national system for faster vaccine coverage and response in future health crises. Focusing on vaccine intention through tailored interventions and targeting hard-to-reach populations could improve vaccine uptake among Syrian refugees.

face barriers to accessing health care, which makes them more prone to under-vaccination. Moreover, they are at increased risk of COVID-19 because they are more likely to live in crowded conditions and to lack access to clean water and hygiene services.[11,13] In January, 2021, the Ministry of Public Health (MOPH) in Lebanon launched a National Deployment Vaccination Plan for COVID-19 vaccines, which aimed to provide free vaccination to all Lebanese residents, including non-citizens and refugees, regardless of legal status.[13] The MOPH COVAX platform also allowed the registration of undocumented refugees or migrants without having to provide their personal identification number.[14]

As of Sept 14, 2022, 593 140 Syrian residents in Lebanon had registered on the MOPH COVAX platform and received 597 096 vaccine doses (including one, two, or three doses). Among an estimated 3·8 million Lebanese nationals, 2 874 541 had registered on the platform and received 4 546 556 vaccine doses (including one, two, or three doses). The reported rate of full vaccination (two doses or more) among this group is low compared to the Lebanese population. The types of vaccines received by Syrian refugees through the Lebanese Government were the BNT162b2 (Pfizer–BioNTech) and ChAdOx1 (Oxford–AstraZeneca) vaccines during the study period.[12,15,16] Vaccine hesitancy among migrants and refugees in Lebanon is high, mainly due to concerns over vaccine safety, side-effects, and registration requirements.[17] Notably, in 2015, UNHCR suspended refugee registration in Lebanon at the government's request. The COVAX registration platform was developed and managed by the Lebanese Government; consequently, undocumented refugees were apprehensive about being registered due to fears of deportation. A study of older Syrian refugees in Lebanon identified various predictors of COVID-19 vaccine intention, including sex, age, education, living outside informal tented settlements, perceiving vaccines as not safe or effective, and using social media as a source of information about COVID-19.[10]

To date, research on actual COVID-19 vaccination status among Syrian refugees in the Arab region has been scarce. Understanding the predictors influencing vaccine uptake in this vulnerable population is crucial to improve vaccination programmes, ensure vaccine equity, and enhance response strategies related to COVID-19 and future outbreaks. We aimed to elucidate the predictors of COVID-19 vaccine uptake among Syrian refugees aged 50 years or older in Lebanon and to understand the main reasons for not receiving the vaccine.

Methods

Study design and setting

This was a cross-sectional analysis of a five-wave longitudinal study that aimed to track the vulnerabilities to COVID-19 of older Syrian refugees residing in Lebanon over time. In particular, this study focused on adults aged 50 years or older since they are at increased risk of morbidity and mortality from COVID-19 due to a higher prevalence of underlying chronic health conditions, clustered with displacement-related social vulnerabilities.[12] The study followed the TRIPOD reporting guidelines and STROBE reporting guidelines for prediction modelling.[18,19]

This study was approved by the American University of Beirut Social and Behavioral Sciences Institutional

Review Board (reference: SBS-2020-0329). Consent to participate was obtained verbally from all participants.

Sampling and study population

The sampling frame included all households in Lebanon that received assistance from the Norwegian Refugee Council, a humanitarian, non-governmental organisation, between 2017 and 2020, and had a Syrian adult aged 50 years or older (n=17 384). All households in the sample listing were contacted and Syrian refugees aged 50 years or older were invited to participate in the study. If a household included more than one eligible participant, one adult was randomly chosen with a computer algorithm in KoBotoolbox. Verbal consent was taken from all participants and those aged 65 years or older were assessed for capacity to consent.[20] The same participants were contacted to complete a computer-assisted telephone interview conducted by a trained data collector across five waves from Sept 22, 2020, to March 14, 2022. Our sample included participants who completed wave 3 and wave 5.

Data sources

The questionnaire for each wave was developed with multiple sources, including existing validated scales and contextualised questions, and was co-created by academics, humanitarian workers, government representatives, and focal points from the refugee community. The survey tool was drafted in English and then translated into Arabic. Before onset of data collection, the Arabic version of the questionnaire was piloted internally with data collectors and local community focal points for face validity. Several adjustments to the survey instrument were conducted on the basis of the pilot test, community consultations, and data collectors' training to ensure contextualisation and face validity. The survey was administered in Arabic over the telephone by trained data collectors and data entry was done with Kobo toolbox. Data were monitored daily in parallel with data collection for quality assurance. Different questions or modules were included at different waves. More details about the development of the survey tool have been previously described.[21] For the present analysis, data were extracted from two study waves: wave 3 (Jan 21–April 23, 2021), which was administered during the early phases of the COVID-19 vaccine roll-out and included a question on vaccine safety and on whether participants intended to receive the COVID-19 vaccine; and wave 5 (Jan 14–March 14, 2022), which was administered 11 months after vaccine roll-out and included questions on actual vaccine uptake.

Outcome measures

COVID-19 vaccine uptake was the primary outcome of interest. Each participant was asked the following questions in wave 5: "Have you received the COVID-19 vaccine?" and "If yes, did you receive the second/third dose of the vaccine?" The collected data in response to the questions were categorised into two binary outcomes: receiving at least one dose of a COVID-19 vaccine and receiving two doses or more of a COVID-19 vaccine. Additionally, participants were asked about the reasons for not taking the vaccine (appendix p 2).

See Online for appendix

Possible predictors

Based on the literature, the following possible predictors for vaccine uptake were included: sociodemographic variables age, sex, residence outside or inside informal tented settlements, education and employment status; intention to receive the vaccine; number of chronic disease conditions; perception of vaccine safety; and receipt of cash assistance (appendix p 2).

The missing values were assumed to be missing at random. As they did not exceed 5% for all predictors, a complete case analysis was performed.[22]

Statistical analysis

Frequencies and percentages were reported for categorical variables, and medians and IQRs were reported for continuous variables. Unadjusted odds ratios (ORs) along with their 95% CIs were reported for predictors across the two outcome variables: receiving at least one COVID-19 vaccine dose compared to none; receiving two COVID-19 vaccine doses or more compared to none. A p value less than 0·05 was considered statistically significant.

All candidate predictors were categorical except for age, which had a linear relationship with each outcome. A stepwise backwards multivariable logistic regression model was used, where all candidate predictors were entered into the model and those with a p value less than 0·157 were removed.[23] Multicollinearity was assessed and a variance inflation factor higher than five indicated collinearity.

The C-statistic was used to assess the final model's performance in terms of discrimination. It is also known as the area under the receiver operating characteristic curve and ranges from 0·5 (a discriminative ability equal to chance) to 1·0 (perfect discriminative ability between those with and without the outcome). The evaluation of the model's calibration, which determines the agreement between observed outcomes and predictive probabilities, was performed by analysing calibration plots and slope. An ideal calibration is illustrated by a diagonal line on the graph with a slope of 1 and an intercept of 0. If the slope is less than 1, it implies that the model has been overfitted.[24] Additionally, calibration-in-the-large (CITL) was assessed to identify the overall difference between the observed number of events and the average predictive risk.

The final model was internally validated with bootstrap methods, where 500 bootstrap samples with replacement were used to assess the model's optimism. The optimism-adjusted estimates of the C-statistic and

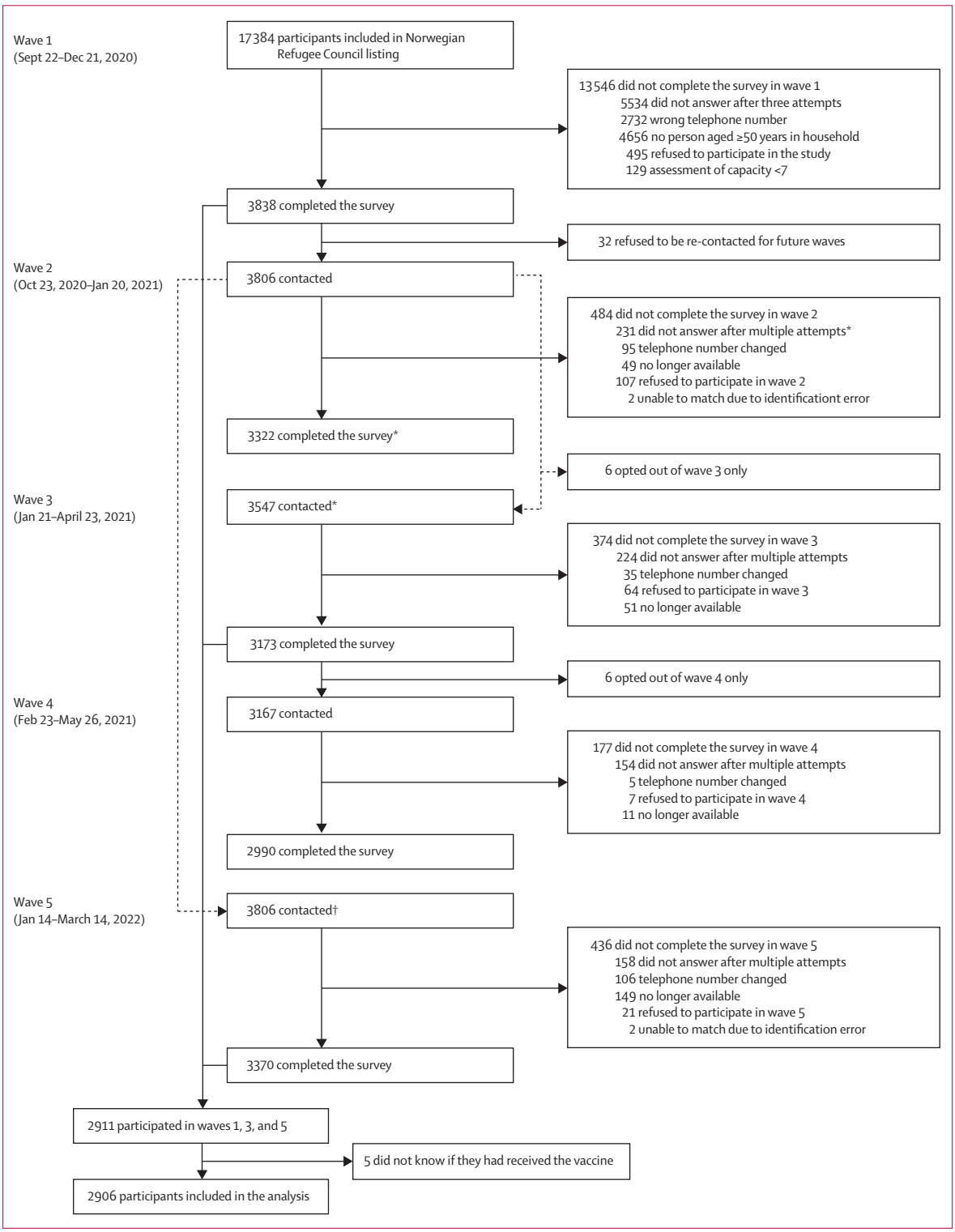

Figure 1: **Flow diagram of Syrian refugees included in the study population**
*Wave 3 included all participants who participated in wave 2, who accepted to participate in future waves, and those who did not answer after multiple attempts at wave 2. †All participants who provided consent in wave 1 were re-contacted at wave 5.

optimism-adjusted calibration plot were generated.[22,24–26] Finally, bootstrap shrinkage was applied to the final apparent model, giving adjusted coefficients and ORs. All analyses were done with Stata/SE 17.

Role of the funding source

The funder, ELRHA's Research for Health in Humanitarian Crisis Programme, had no role in the design and conduct of the study; in the collection, management, analysis, and interpretation of the data; in the preparation, review, or approval of the manuscript; or in the decision to submit the manuscript for publication.

Results

Of 3838 Syrian refugees who completed the first wave, 3173 participated in wave 3; of those, 2906 participants completed wave 5 and responded to the vaccine uptake question (figure 1). The median age of the study sample was 58 years (IQR 55–64; range 52–100); 52·9% were male and 62·7% lived outside tented settlements (table 1).

Of 2906 participants, 1671 (57·5%) reported not receiving any dose of COVID-19 vaccine in wave 5; 429 (14·8%) of 2906 reported only receiving one dose; and 806 (27·7%) of 2906 reported receiving two doses of the vaccine and 26 (0·9%) of 2906 reported receiving the third dose (table 1; figure 2). The main reasons for not receiving the first dose of the vaccine included being afraid of the vaccine side-effects, followed by not wanting the vaccine and still waiting to register or to be called for an appointment. The main reasons for not receiving the second dose of the vaccine were that the participants

	Total (n=2906)	No dose taken (n=1671)	Only one dose taken (n=429)	Two or more doses taken (n=806)	Two or more doses taken *vs* none; OR (95% CI)	At least one dose taken *vs* none; OR (95% CI)
Age* (years)	58 (55–64)	59 (55–65)	57 (54–62)	57 (54–62)	0·96 (0·95–0·97)	0·96 (0·95–0·97)
Sex						
Female	1368 (47·1%)	878 (52·5%)	178 (41·5%)	312 (38·7%)	Ref	Ref
Male	1538 (52·9%)	793 (47·5%)	251 (58·5%)	494 (61·3%)	1·75 (1·48–2·08)	1·68 (1·45–1·95)
Residence						
Outside informal tented settlements	1822 (62·7%)	1109 (66·4%)	256 (59·7%)	457 (56·7%)	Ref	Ref
Inside informal tented settlements	1084 (37·3%)	562 (33·6%)	173 (40·3%)	349 (43·3%)	1·51 (1·27–1·79)	1·44 (1·24–1·68)
Education						
Never attended school	1379 (47·6%)	862 (51·8%)	196 (45·8%)	321 (39·8%)	Ref	Ref
Elementary	762 (26·3%)	400 (24·0%)	117 (27·3%)	245 (30·4%)	1·64 (1·34–2·02)	1·51 (1·26–1·80)
Preparatory and above	757 (26·1%)	402 (24·2%)	115 (26·9%)	240 (29·8%)	1·60 (1·31–1·97)	1·47 (1·23–1·76)
Missing	8	7	1	0	..	..
Chronic health conditions						
At least one	2172 (76·4%)	1272 (77·7%)	310 (74·5%)	590 (74·7%)	Ref	Ref
None	671 (23·6%)	365 (22·3%)	106 (25·5%)	200 (25·3%)	1·18 (0·97–1·44)	1·18 (0·99–1·41)
Missing	63	34	13	16	..	..
Vaccination perceptions: "I think vaccines are safe"						
Disagree	325 (11·2%)	211 (12·6%)	36 (8·4%)	78 (9·7%)	Ref	Ref
Agree	2084 (71·7%)	1174 (70·3%)	327 (76·2%)	583 (72·3%)	1·34 (1·02–1·77)	1·43 (1·12–1·83)
Neither agree nor disagree or don't know	497 (17·1%)	286 (17·1%)	66 (15·4%)	145 (18·0%)	1·37 (0·99–1·90)	1·36 (1·02–1·82)
Received cash assistance in last month						
No	197 (6·8%)	114 (6·8%)	31 (7·2%)	52 (6·5%)	Ref	Ref
Yes	2704 (93·2%)	1553 (93·2%)	398 (92·8%)	753 (93·5%)	1·06 (0·76–1·49)	1·02 (0·76–1·36)
Missing	5	4	0	1	..	..
Intention to receive vaccination						
Refuse	911 (31·4%)	571 (34·2%)	119 (27·7%)	221 (27·5%)	Ref	Ref
Accept	1769 (61·0%)	966 (57·9%)	281 (65·5%)	522 (65·0%)	1·40 (1·16–1·68)	1·40 (1·18–1·64)
Don't know	220 (7·6%)	131 (7·8%)	29 (6·8%)	60 (7·5%)	1·18 (0·84–1·67)	1·14 (0·84–1·54))
Missing	6	3	0	3	..	..

Data are n (%) or median (IQR), unless otherwise stated. OR=odds ratio. *Age was a continuous variable; increasing age was associated with decreased odds of receiving the COVID-19 vaccine.

Table 1: **Characteristics of older Syrian refugees in Lebanon and the associations of these characteristics with COVID-19 vaccine uptake**

were waiting for a text message for an appointment after having registered or reported being afraid of side-effects or not wanting to receive the vaccine. Moreover, the main reasons for not receiving the third dose were that participants were waiting for a text message to schedule an appointment, and did not want to receive the vaccine or considered that two doses were enough (figure 2).

The unadjusted analysis showed that older age was associated with decreased odds of receiving at least one dose of the COVID-19 vaccine. Furthermore, the likelihood of receiving at least one dose of the vaccine in wave 5 was higher in male than in female participants, in participants who lived inside informal tented settlements than in those living outside, in participants with elementary and preparatory education or above compared with those who never attended school, in those who agreed with the statement that "vaccines are safe" compared with those who disagreed with it, and in those who had reported intention to receive the vaccine in wave 3 compared with those who did not report an intention to receive it (table 1). The characteristics of Syrian refugees who received at least one dose of the COVID-19 vaccine were similar to those who received two or more doses of the vaccine (table 1).

The final model identified five predictors of receiving at least one dose of the COVID-19 vaccine in wave 5: age, sex, residence, education, and earlier intention to receive the vaccine (table 2). Thereby, after adjustment for optimism (figure 3; the calibration plot before correction for optimism is provided in appendix p 3), the final model had a C-statistic of 0·605 (95% CI 0·584 to 0·624), which indicates a moderate discriminative ability, as well as a calibration slope of 0·912 (95% CI 0·758 to 1·079), Brier score of 3·3, and CITL of 0·001 (95% CI –0·074 to 0·073; appendix [p 3]; figure 3). ORs and coefficients of the final model have been adjusted for overfitting using bootstrap shrinkage (table 2).

A second predictive model examined the predictors of receiving at least two doses of the vaccine compared to none (appendix p 4). This model identified the same five predictors as the model predicting at least one dose of the vaccine. The final model had an optimised adjusted C-statistic of 0·611 (95% CI 0·588–0·635) and a calibration slope of 0·905 (95% CI 0·750–1·080).

The associations of the predictors' coefficients with the outcome were all in the expected direction; being male compared to female, living inside informal tented settlements compared to living outside, having higher education, and reporting intention to receive the vaccine in wave 3 had positive coefficients and therefore were associated with a higher probability of receiving at least one dose of the COVID-19 vaccine in wave 5. Only age had a negative coefficient, meaning that older age was associated with a lower likelihood of receiving the vaccine.

To illustrate, for a Syrian refugee who is female, aged 85 years, who never attended school, residing outside informal tended settlements, and who did not intend to receive the vaccine, the predicted probability of receiving at least one dose of the COVID-19 vaccine was 7·6%. However, for a Syrian refugee who is male, aged 50 years, with an elementary education, residing inside informal tended settlements, and intended to receive the vaccine, the predicted probability of receiving at least one dose of the COVID-19 vaccine was 42·8%.

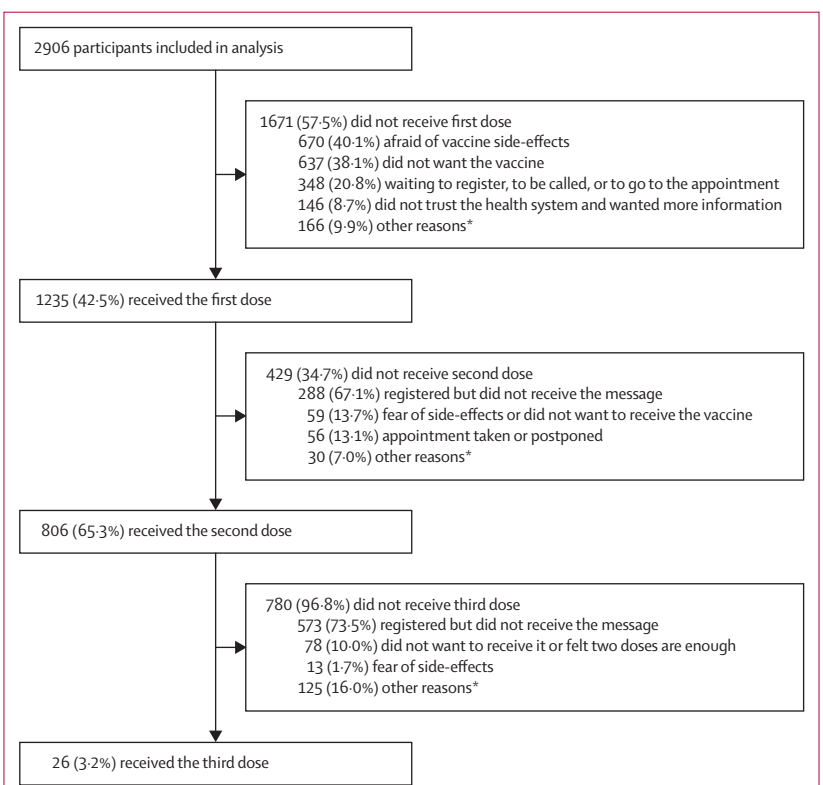

Figure 2: **Vaccination prevalence and reasons for not receiving first, second, and third dose of COVID-19 vaccine**
Participants cited several reasons for not receiving the vaccine, so the numbers do not total those listed on the left. *Includes those who were unable to access the vaccine centre, those who were ill, those who developed COVID-19, those who were afraid of needles, and so on.

Discussion

This study showed that 57·5% of Syrian refugees aged 50 years and older in Lebanon had not received any dose of the COVID-19 vaccine by March, 2022. It also identified five predictors of receiving at least one dose of the COVID-19 vaccine among older Syrian refugees: younger age, being male, living inside informal tented settlements, having elementary and preparatory education or above, and having a pre-existing intention to receive the vaccine. The predictive model had a moderate discriminative ability and good calibration. The primary reasons for not receiving the vaccine included being afraid of its side-effects, not wanting to receive the vaccine, or waiting for an appointment after registering on the MOPH COVAX platform. The main reason for not receiving the second or third dose of the vaccine was waiting for an appointment after having registered.

	Apparent model			Model adjusted by bootstrap shrinkage		
	Parameter estimate (95% CI)	Odds ratio (95% CI)	p value	Parameter estimate (95% CI)	Odds ratio (95% CI)	p value
Age	–0·03 (–0·04 to –0·02)	0·97 (0·96 to 0·98)	<0·0001	–0·03 (–0·04 to –0·02)	0·97 (0·96 to 0·98)	<0·0001
Sex						
Female	Ref	Ref	..	..	Ref	..
Male	0·36 (0·19 to 0·53)	1·43 (1·21 to 1·70)	<0·0001	0·33 (0·17 to 0·48)	1·39 (1·19 to 1·62)	<0·0001
Residence						
Outside informal tented settlements	Ref	Ref	..	..	Ref	..
Inside informal tented settlements	0·40 (0·24 to 0·55)	1·49 (1·27 to 1·74)	<0·0001	0·36 (0·22 to 0·51)	1·44 (1·24 to 1·66)	<0·0001
Education						
Never attended school	Ref	Ref	..	..	Ref	..
Elementary	0·23 (0·03 to 0·43)	1·26 (1·03 to 1·53)	0·024	0·21 (0·03 to 0·39)	1·23 (1·03 to 1·48)	0·024
Preparatory and higher	0·16 (–0·05 to 0·37)	1·17 (0·95 to 1·44)	0·14	0·14 (–0·05 to 0·33)	1·15 (0·95 to 1·40)	0·14
Intention to receive vaccination						
Refuse	Ref	Ref	..	..	Ref	..
Accept	0·27 (0·11 to 0·44)	1·32 (1·11 to 1·56)	0·001	0·25 (0·10 to 0·40)	1·29 (1·10 to 1·50)	0·001
Don't know	0·13 (–0·18 to 0·43)	1·13 (0·83 to 1·54)	0·42	0·11 (–0·16 to 0·40)	1·12 (0·85 to 1·48)	0·42
Intercept	0·09 (–0·69 to 0·87)	1·09 (0·50 to 2·40)	0·82	0·06 (–0·02 to 0·13)	1·06 (0·98 to 1·14)	0·13

Table 2: **Multivariable model for predicting uptake of at least one dose of the COVID-19 vaccine**

This study showed that COVID-19 vaccine uptake (ie, receipt of at least one dose) among older Syrian refugees in Lebanon was 42·5%. This observed prevalence was lower than the national average of 45·9% (at the time of data collection) and the suggested threshold of 67% for COVID-19 herd immunity.[2] Further information on the available data on vaccine registration and uptake is provided in appendix (p 5). Despite the efforts by international organisations and the MOPH to ease the registration process, our results indicate an urgent need for public health interventions that highlight the importance of vaccination against COVID-19. The prevalence of COVID-19 vaccine uptake reported in the present study is higher than that of a study in refugees from multiple nationalities living in Australia, where only 12% were reported to be vaccinated.[5]

The main reasons for not receiving the vaccine that emerged from this study included not wanting the vaccine or being afraid of its side-effects. Although there is a paucity of studies that target vaccine acceptance among Syrian refugees in the Middle East, these findings correspond with other studies in migrants in the UK and the general population in Europe and the USA.[7,27] Other reasons for not taking the vaccine reported in the literature included concerns about its effectiveness, inadequate knowledge about its importance, religious reasons, and the belief that COVID-19 is not a serious infection.[1] To counter misinformation about the COVID-19 vaccine, community-based interventions are needed in populations at high-risk, such as Syrian refugees. Moreover, it might be more advantageous for information about COVID-19 to be disseminated by health-care professionals and local religious leaders, rather than relying solely on social media.[6]

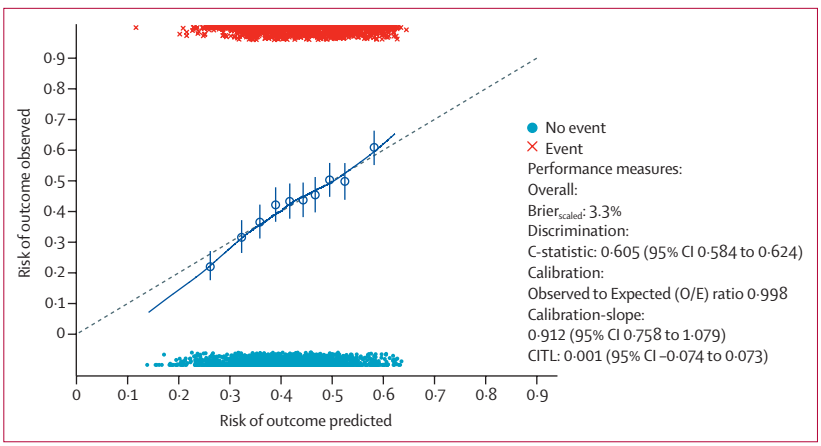

Figure 3: **Model performance in the optimised-adjusted model**
CITL=calibration-in-the-large.

The main reason for not receiving the second or third doses of the vaccine was that the participants were still waiting for an appointment after registering. The findings of this study highlight the importance of future research to compare vaccination rates across different nationalities residing in Lebanon and to ascertain the reasons for the delay between registration and appointments. Notably, the Lebanese Government must prioritise vulnerable populations and collaborate with humanitarian agencies to strengthen the national immunisation system by reducing the waiting time between registration and appointments. Improving COVID-19 vaccination strategies is crucial to preventing future outbreaks in Lebanon as well as strengthening the response to other emerging outbreaks and future health threats.

Our study showed that men were more likely to receive at least one dose of the COVID-19 vaccine than women. Although research about vaccine uptake is scarce, this finding is consistent with the results of studies in the general population in Kuwait and the USA, which showed that men were more likely to intend to take the vaccine than women.[6,8] Further research should aim to understand the reasons for this difference between the sexes, which is embedded in how unequal gender roles operate in the particular context of displacement. Older Syrian refugee women might engage less than men outside the privacy of the home; as a result, they might believe that they are at low risk and thus do not need to receive the vaccine. Through a gendered lens, humanitarian organisations should aim to better understand the link between gender and vaccine uptake and, thus, would be able to design tailored and more effective awareness programmes.

Another predictor for COVID-19 vaccine uptake that emerged from this study was younger age, which is in contrast to a study done in the general population in the USA, showing that vaccine uptake increases with age.[9] Such conflicting results could be due to regional and cultural differences in perceptions about vaccination, which vary across age groups. Nonetheless, age is a biological risk factor for more severe COVID-19 illness; therefore, humanitarian organisations should focus their efforts on older age groups to better understand and overcome the barriers to vaccine uptake in this population.

As expected, we found that older Syrian refugees with higher levels of education were more likely to receive the COVID-19 vaccine than those who never attended school. Although most studies in the literature examine the relationship between vaccine intention (not uptake) and education, this finding corresponds with previous studies in the general population in the USA.[28] Furthermore, vaccine literacy can increase vaccine uptake as it encompasses knowledge about the importance of vaccination.[29]

Older Syrian refugees living inside informal tented settlements had a higher likelihood of receiving the vaccine than those in residential areas. Refugees in enclosed geographical areas such as camps are more accessible to humanitarian organisations via mobile clinics or vaccination campaigns compared to those living in residential areas.[30] Humanitarian organisations must broaden their vaccination programmes through registration centres, community centres, community-based volunteers, mobile health clinics, and municipalities, in order to reach all refugees and prevent inequalities in vaccine uptake.

Additional predictors for vaccine uptake identified in the literature, but not present in our model, included self-perceived vulnerability to COVID-19 and information about COVID-19 vaccines.[1] The incorporation of these predictors might have improved the discrimination of our study's model. Hence, additional studies in the Middle East are crucial to further understand the characteristics of communities at risk of having low vaccination uptake, to design tailored vaccination programmes related to COVID-19, and ultimately improve rates of vaccine uptake, specifically among vulnerable populations.

This study is subject to several limitations. The study outcome was self-reported and might be prone to information bias. Furthermore, the study sample is representative of beneficiaries from a single humanitarian organisation and not all Syrian refugees residing in Lebanon. It is likely that this study population is comparable to older refugees receiving humanitarian assistance in Lebanon. Consequently, future research should aim to complete representative studies to avoid issues related to selection bias.

In conclusion, since the COVID-19 vaccine is widely available in Lebanon, our findings confirm the ongoing need to address vaccine uptake among older Syrian refugees. Access to vaccination for the most vulnerable populations, such as Syrian refugees, is crucial to curtail the spread of COVID-19 and future outbreaks. Lebanon, a country already overwhelmed by economic and political crises, requires further strengthening to improve deployment planning, raise awareness about the importance of vaccination, and enhance the national health system for a faster response to future health crises.

Contributors

SAb, HG, and SJM conceptualised the study and the survey design. SAb, SJM, BAZ, and TEK contributed to data collection and analysis. BAZ and TEK contributed to the literature search and wrote the first draft of the manuscript; subsequent drafts were reviewed and revised by SJM and SAb. The underlying survey data were verified by SJM and BAZ. SJM supervised BAZ and TEK throughout the project. ZR was involved in the administration and implementation of the study. ZR, SAn, and MFA contributed to the interpretation of the results. All authors have reviewed and approved the final version of the Article. SJM, TEK, and BAZ had full access to and verified the raw data. All authors had access to the study data and had final responsibility for the decision to submit the manuscript for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The anonymised data can be obtained upon reasonable request from the Norwegian Refugee Council (nrc@nrc.no) and the American University of Beirut (crph@aub.edu.lb).

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