Title: Willingness to receive a COVID-19 vaccine among adults at high-risk of COVID-19: a UK-wide survey

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ABSTRACT

Purpose Willingness of adults at high-risk of COVID-19 to receive a COVID-19 vaccine is unknown. There are key disparities in the risk and outcomes from COVID-19 by socio-demographic factors, including age, sex, level of deprivation, and ethnicity. A COVID-19 vaccination programme could inadvertently exacerbate these inequalities if it is not readily received by different population groups. In this UK-wide cross-sectional survey, we examined willingness to receive a COVID-19 vaccine in the general population and evaluated socio-demographic and clinical factors associated with willingness.

Methods Between April and June 2020, individuals in the general population were invited to complete an online survey; 2568 provided informed consent. Willingness to receive a COVID-19 vaccine was reported by 2152 (83.8%).

Results In total, 76.9% (1654/2152) reported being willing to receive a COVID-19 vaccine. One in five individuals at increased risk of COVID-19, as defined by UK government guidelines, were unwilling to receive a COVID-19 vaccine (119/589; 20.2%). Individuals from white ethnic group were more likely to be willing to receive a COVID-19 vaccine compared with those from BAME groups (79.9% vs. 55.9%, respectively), OR 2.84, 95% CI = 1.93 – 4.18, $p \leq 0.001$. Willingness did not vary among adults at increased risk of COVID-19 compared with those not at increased risk.

Conclusion A significant proportion of individuals in the general population are unwilling to receive a COVID-19 vaccine, including those at increased risk of COVID-19 morbidity and mortality. There are socio-demographic differences in willingness, especially by ethnic group. Success of a vaccination programme for COVID-19 depends not only on the efficacy of the vaccine but also on its uptake. Research is urgently needed to establish the most effective policy and communications to encourage maximal uptake of the vaccination.

BACKGROUND

Companies and academic institutions worldwide are working to develop a vaccine for COVID-19, a disease caused by coronavirus SARS-CoV-2. There are more than 100 vaccines being developed and tested worldwide, with two in Phase III development [1]. Older people, people with pre-existing health conditions, and pregnant women to be at higher risk from COVID-19 [2]. It is likely that people in these high-risk groups, as well as front-line healthcare workers, will be prioritised for vaccination. Key disparities in the risk and outcomes of COVID-19 have been identified by Public Health England (PHE) in terms of socio-demographic factors, including age, sex, level of deprivation, and ethnicity [3]. Although the existence of comorbidities that increase the risk of developing serious complications is likely to account for some of these differences [4], disparities in COVID-19 exposure and outcomes are also likely to reflect the existence of structural barriers [5]. The UK's Institute for Fiscal Studies (IFS) reported that increased risk of infection through occupational profile and exposure may partially explain disproportionate deaths observed in some black, Asian, and minority ethnic (BAME) communities [6]. There is also a strong association between socioeconomic deprivation and the ability to adopt protective behaviours, with those from disadvantaged backgrounds less likely to be able to work from home or self-isolate when needed [7]. It is apparent that different groups of people are affected by COVID-19 differently, meaning that different strategies may be needed to ensure uptake of any future COVID-19 vaccine.

The effectiveness of a COVID-19 vaccination programme depends on adequate uptake. Early estimates of the basic reproduction number (R_0) for COVID-19 was estimated at 2.2 [8], but recent estimates report that this might be as high as 5.7 [9]. This suggests that between 55% and 82% of the population need to be immune, either through vaccination or prior infection, to stop COVID-19 transmission [9].

Uptake can be low for vaccination programmes for communicable diseases. In the UK, influenza vaccination is recommended for individuals at increased risk of influenza-related morbidity and mortality. PHE reported that during the 2019 and 2020 season, only 44.9% of individuals aged under 65 years of age with one or more underlying clinical risk factors received their influenza vaccination [10]. Similarly, vaccine hesitancy is likely to be a major barrier to the uptake of a future COVID-19 vaccine. If a vaccine is less readily accepted by particular groups of individuals, there is the potential for the vaccine to inadvertently create or exacerbate socio-demographic and clinical disparities in COVID-19 incidence and mortality.

Public health messaging and communications play a key role in informing the public of how to manage risks and prevent transmission during public health pandemics, including vaccination acceptance and uptake [11]. Behaviour change frameworks, such as the Behaviour Change Wheel (BCW) [12] provides a framework for understanding the social, psychological, and environmental influences on health behaviours and the development of public health communications and policies to change those behaviours, including vaccination uptake [13]. Recently, the British Psychological Society (BPS) Behavioural Science and Disease Prevention Taskforce released brief guidance to inform public health messaging for reducing the spread of COVID-19 [14].

We anticipate that policy and communications to encourage uptake of the vaccine will need to be implemented. It is crucial that we identify willingness to receive a COVID-19 vaccine across different groups of individuals so interventions can be put in place to mitigate those issues.

The objectives of this study were to: (1) examine the extent to which people in the UK population are willing to receive a COVID-19 vaccine if one was to become available and; (2) determine whether socio-demographic and clinical factors are associated with willingness to receive a COVID-19 vaccine.

METHODS

SAMPLE

We conducted a national cross-sectional online survey of individuals in the UK general population, between April 2020 and June 2020 in two separate samples. For our first sample, individuals were recruited via adverts on social media and emails. For our second sample, DJS (a private research company) invited participants from a research panel to take part in the survey via email, with quotas set for gender, age, and region. Both samples were combined for this study. The survey was hosted on Qualtrics.

Respondents were eligible if they were aged 18 years or older, able to provide consent and, were a resident in the UK. University ethical approval was granted from Sheffield Hallam University (ER22810646).

MEASURES

This paper describes the analysis of a sub-section of the questions focused on socio-demographic and clinical factors, and willingness to receive a COVID-19 vaccine.

Socio-demographic variables

The survey contained the following measures, some of which were dichotomised for analysis: location (England vs. Wales, Scotland, Northern Ireland); age; gender; ethnicity (White ethnic group

vs. BAME group); marital status (married/cohabiting vs. widowed, divorced, separated, single); having children ≤ 18 years in their household; having adults ≤ 70 years in their household; having adults ≥ 70 years in their household; employment status (employed full or part-time vs. all other employment types) and; education attainment (degree level or above vs. below degree level). Education attainment was categorised into 'degree level or above', 'education below degree level', and 'no formal qualifications or other', based on the item '*What is the highest level of educational qualification you have obtained*'.

Clinical variables

Respondents reported their current smoking status (never smoked vs. ex-smoker vs. current smoker). Self-reported general health status was assessed with the following item, '*Compared with a typical person of your age and your sex, how good is your health?*' with a 7-point response scale ranging from 'extremely poor [1]' to 'extremely good' [7].

Respondents self-reported their COVID-19 status (has not had COVID-19 vs. has/has had COVID-19). Respondents were presented with a list of health conditions associated with increased risk from COVID-19. The health conditions were taken from UK government guidelines in March 2020, which distinguishes between conditions that are high risk for COVID-19 (clinically extremely vulnerable and shielding) and moderate risk (clinically vulnerable) [2]. For analyses, respondents were categorised into the following groups assessing the individuals' risk of COVID-19: 'The individual is at high risk of COVID-19' (the individual is aged ≥ 70 regardless of medical conditions, ≤ 70 years of age and clinically extremely vulnerable, ≤ 70 years of age and clinically vulnerable) vs. 'The individual is not at high-risk of COVID-19'. Respondents were also categorised into the following groups assessing members of their households risk of COVID-19: 'A member of their household is at high risk of COVID-19' (one or more members of their household is aged ≥ 70 regardless of medical conditions, one or more members of their household is ≤ 70 years of age and clinically extremely vulnerable, one or more members of their household is ≤ 70 years of age and clinically vulnerable) vs. 'No members of their household are at high-risk of COVID-19'.

Willingness to receive a COVID-19 vaccine

Willingness to receive a COVID-19 vaccine was assessed with the following item: '*If a vaccine was available for COVID-19, I would want to receive it*'. Respondents were asked to indicate which of the following response options applied to them (Strongly disagree [1], disagree [2], neither agree nor disagree [3], agree [4], strongly agree [5]), which were dichotomised into willing (responses 4 – 5) and unwilling or unsure groups (responses 1 – 3) for the main analysis. We also conducted sensitivity

analyses to examine whether there were socio-demographic or clinical differences in those who were unsure whether they would or would not receive a COVID-19 vaccine (response 3) if it was to become available, compared with those who disagreed (responses 1 – 2) and those who agreed (responses 4 – 5).

DATA ANALYSIS

The analysis was preregistered [15]. Among respondents providing outcome data on willingness to receive a COVID-19 vaccine, we conducted univariable and multivariable logistic regression to examine the role of high-risk group status on willingness to receive a COVID-19 vaccine, adjusting for participant characteristics. The analysis was undertaken using SPSS version 24.0 (IBM Corp). Statistical significance was set at a 2-sided $P < .05$.

RESULTS

In total, 1149 respondents recruited via social media and emails to contacts clicked the survey link; 895 (77.9%) provided informed consent and of those, 830 (92.7%) provided outcome data on willingness to receive a COVID-19 vaccine. A total of 1729 respondents recruited via DJS clicked the survey link; 1673 (96.8%) provided informed consent and of those, 1322 (79.0%) provided outcome data. Together, 2152 respondents were included in this analysis (Table 1).

The mean age of the sample was 45.3 years old ($SD \pm 16.1$). The majority of the sample were from England (1790; 87.4%), female (1358; 63.2%), from white ethnic backgrounds (1956; 91.0%), educated to degree level or above (1141; 53.0%) and in full or part-time employment (1474; 68.7%). Two thirds of the sample were married or cohabiting (1340; 66.3%), with 35.5% (762) having children ≤ 18 years of age and 32.1% (687) having adults ≤ 70 years of age living in their household (either all of the time or some of the time). Only 12.0% (257) were current smokers.

The majority of the sample self-reported that they had not had COVID-19 (1814; 84.4%). In total, 28.6% (589) of respondents were classified as being in a high-risk group for COVID-19 (either due to age and/or existing health conditions) and 25.7% (524) were classified as having a member of their household classified as being in a high-risk group for COVID-19.

Factors associated with willingness to receive a COVID-19 vaccine

In total, 76.9% (1654) were classified as being willing to receive a COVID-19 vaccine. Just over one in five individuals were unwilling or unsure whether they would receive a COVID-19 vaccine if one were to become available (498; 23.1%).

Willingness to receive a COVID-19 vaccine by socio-demographic and clinical variables is presented in Table 2. Individuals who were older (vs. younger); from white ethnic groups (vs. BAME groups); married or cohabiting (vs. single, widowed, divorced); unemployed (vs. in full or part-time employment); educated to degree level or above (vs. below degree level); a non-smoker or an ex-smoker (vs. a current smoker, for both comparisons) and; had not had COVID-19 (vs. has or has had COVID-19) were significantly more likely to be willing to have a COVID-19 vaccine. Willingness did not vary between other socio-demographic or clinical groups, including high-risk group classification for both the individual and member of their household.

In a multivariable model adjusting for participant characteristics, age, ethnic group, educational level, and smoking status remained significantly associated with willingness to receive a COVID-19 vaccine in multivariable analyses. The largest difference in willingness was for ethnicity; individuals from white ethnic background were more likely to be willing to receive a COVID-19 vaccine compared with those from BAME groups (79.9% vs. 55.9%, respectively), OR 2.84, 95% CI = 1.93 – 4.18, $p \leq 0.001$.

We conducted sensitivity analyses to examine whether the association between ethnicity and willingness remained when examining those who were unsure about receiving a COVID-19 vaccine vs. those who agreed that they would be willing to receive a COVID-19 vaccine. Compared with individuals from white ethnic backgrounds, individuals from BAME groups were significantly more likely to be unsure about receiving a COVID-19 vaccine (28.8% ($n = 42$) vs. 13.6% ($n = 243$), respectively) (OR = 0.39, 95% CI = 0.27 – 0.57, $p \leq 0.001$) compared with strongly agreeing or agreeing that they would be willing to receive a COVID-19 vaccine. There was no significant association between ethnicity and willingness when examining those who were unsure about receiving a COVID-19 vaccine vs. those who disagreed or strongly disagreed that they would be willing to receive a COVID-19 vaccine (OR = 0.73, 95% CI = 0.45 – 1.18), $p = 0.195$.

DISCUSSION

In this UK-wide cross-sectional survey, just over one in five individuals were unwilling to receive a COVID-19 vaccine if one was to become available. The established intention-behaviour gap [16] means it is likely that a number of people who report being willing to receive a COVID-19 will not go on to actually receive a vaccine when it becomes available. Without appropriate interventions to support informed treatment decision-making and the ability to obtain a vaccination, low levels of uptake will seriously limit the effectiveness of a future COVID-19 vaccination programme.

Willingness did not vary among adults at increased risk of COVID-19 compared with those not at increased risk. People with existing comorbidities are at increased risk of serious adverse outcomes [17, 18]. Ensuring optimal vaccination uptake in high-risk groups is essential to reduce the impact of COVID-19.

It is crucial that we monitor the future uptake of the vaccine and understand the determinants of vaccination behaviour among people at increased risk of COVID-19 mortality and morbidity to ensure effective interventions can be put in place. This requires substantial investment in behavioural science research that needs to happen now, while vaccinations are being developed and tested, so that appropriate policies and communications can be made ready to use in advance of the roll-out of the vaccination programme.

There is evidence that people from an ethnic minority background are less likely to receive an influenza vaccination [19, 20]. We have shown that individuals from BAME groups will be less likely to take up the offer of a COVID-19 vaccine if invited. There are considerable disparities observed across ethnic groups with respect to COVID-19 exposure and outcomes [3], which may reflect the existence of comorbidities, such as diabetes, hypertension, and cardiovascular disease [4], the existence of structural barriers, including household structures, occupational profiles, and economic vulnerabilities [6], or behavioural factors, including health-seeking behaviour [21]. Without appropriate interventions, which may include new or adapted communications or policies, this finding highlights the potential for these disparities to be exacerbated following the introduction of the vaccination programme.

The factors influencing the future uptake of a COVID-19 vaccine are largely unknown. There is a wealth of evidence demonstrating that individuals' beliefs about medication, including their perceptions of personal need and concerns about its usage, are key to treatment decision-making [22]. The Protection Motivation Theory has been shown to be a useful framework for understanding modifiable factors associated with pandemic flu vaccination uptake, with threat appraisals (i.e. perceiving flu as a threat) and coping appraisals (i.e. viewing vaccination as an effective coping strategy) associated with vaccination uptake [23]. In addition to these *motivational* factors, according to the COM-B model [12] an individual also needs to have the *capability* and the *opportunity* to receive their vaccine. Capability refers to whether the individual has the psychological and physical ability to obtain their immunisation, which includes having the necessary knowledge and skills. Opportunity refers to whether the physical and social environment make the uptake of immunisations possible or prompt it.

The present study has limitations. Data were collected using an online survey and so there is the risk of inaccurate self-reporting and selection bias. Our outcome variable was a measure of behavioural intentions, rather than actual behaviour, and this is likely to be an under-estimation of future behaviour. Although we implemented targeted recruitment strategies to improve the representation of the general population in the UK, the proportion of individuals from BAME groups who responded to the survey was low (186; 8.7%) consistent with research showing lower participation in research by people from BAME groups [24].

In conclusion, there is an urgent need for researchers and policy makers to examine an individuals' capability, opportunity, and motivation to receive their COVID-19 vaccine and to examine how these barriers and facilitators vary by different groups, especially those at increased risk of COVID-19 and BAME groups. In line with recent PHE recommendations for reducing disparities in the risk and outcomes of COVID-19 [3], this will allow us to create new or adapt existing policies to reduce the impact of COVID-19 in different groups of people by ensuring that uptake of the COVID-19 vaccination is maximised.

Tables

Table 1. Sample characteristics (n = 2152)

Variable		Value
Location	England	1790 (87.4%)
	Wales	82 (4.0%)
	Scotland	132 (6.4%)
	Northern Ireland	44 (2.1%)
	Missing	104
Age	Mean $\pm$ SD, range	45.31 $\pm$ 16.07, 18 – 99 years
	Missing	13
Gender	Male	786 (36.6%)
	Female	1358 (63.2%)
	Other	1 (0.0%)
	Prefer not to say	4 (0.2%)
	Missing	3
Ethnic group	White ^a	1956 (91.0%)
	BAME ^b	186 (8.7%)
	Prefer not to say	8 (0.4%)
	Missing	2
Marital status	Married or cohabiting	1340 (66.3%)
	Other ^c	663 (32.8%)
	Prefer not to say	18 (0.9%)
	Missing	131
Children ($\leq$ 18 years) living in the household	Yes, or sometimes	762 (35.5%)
	No	1387 (64.5%)
	Missing	3
Adults ($\leq$ 70 years) living in the household	Yes, or sometimes	687 (32.1%)
	No	1456 (67.9%)
	Missing	9
Employment status	Employed full or part-time ^d	1474 (68.7%)
	Other types of (un)employment ^e	659 (30.7%)
	Prefer not to say	12 (0.6%)
	Missing	7
Educational level	Below degree level	920 (42.8%)
	Degree or above	1141 (53.0%)
	No formal qualifications/ other	70 (3.3%)
	Prefer not to say	21 (1.0%)
Smoking status	Never smoked	1233 (57.8%)
	Ex-smoker	645 (30.2%)
	Current smoker	257 (12.0%)
	Missing	17
Health status	Mean $\pm$ SD, range	4.76 $\pm$ 1.47, 1 - 7
	Missing	2
COVID-19 status	Not had COVID-19	1814 (84.4%)
	Has or has had COVID-19 (without or without an antibody test)	336 (15.6%)

	<i>Missing</i>	2
High-risk group (individual)	Aged $\geq$ 70 years (regardless of medical conditions)	142 (6.9%)
	Aged $\leq$ 70 years and clinically extremely vulnerable	74 (3.6%)
	Aged $\leq$ 70 years and clinically vulnerable	373 (18.1%)
	Not in a high-risk group	1400 (68.1%)
	Other/ Not sure	64 (3.1%)
	Prefer not to say	3 (0.1%)
	<i>Missing</i>	96
High-risk group (member of household)	Aged $\geq$ 70 years (regardless of medical conditions)	164 (8.0%)
	Aged $\leq$ 70 years and clinically extremely vulnerable	60 (2.9%)
	Aged $\leq$ 70 years and clinically vulnerable	300 (14.7%)
	Not in a high-risk group	1449 (71.0%)
	Other/ Not sure	60 (2.9%)
	Prefer not to say	7 (0.3%)
	<i>Missing</i>	112
Willingness to receive a COVID-19 vaccine	Willing	1654 (76.9%)
	Unwilling or unsure	498 (23.1%)

Key: ^a includes White – British; White - Irish/White - Any other White background. ^b includes Mixed – White & Black Caribbean/Mixed - White & Black African; Mixed - White & Asian; Mixed - Any other Mixed background; Black or Black British – Caribbean; Black or Black British – African; Black or Black British - Any other Black background; Asian or Asian British – Indian; Asian or Asian British – Pakistani; Asian or Asian British – Bangladeshi; Asian or Asian British - Any other Asian background; Chinese. ^c includes widowed; divorced; separated; single. ^d includes employed full-time and currently working / furloughed/ currently on leave, employed part-time and currently working / furloughed / currently on leave, self-employed. ^e unemployed and looking for work / unable to work / homemaker / retired/ student/volunteer.

Table 2. Willingness to receive a COVID-19 vaccine according to participant characteristics and univariable and multivariable logistic regression model (*n* = 1651)

Willingness to receive a COVID-19 vaccine (N; %)			Univariable		Multivariable	
			OR (95% CI)	P-value	OR (95% CI)	P-value
Location	England	1366 (76.3%)	0.83 (0.60 – 1.15)	0.264	0.83 (0.56 – 1.21)	0.325
	Other	205 (79.5%)	Ref		Ref	Ref
Age	Mean ± SD	46.48 ± 16.04 (vs. 41.39 ± 15.52)	1.02 (1.01 – 1.03)	≤ 0.001	1.01 (1.00 – 1.02)	0.018
Gender	Female	1051 (77.4%)	Ref		Ref	
	Male	598 (76.1%)	0.93 (0.76 – 1.14)	0.487	0.93 (0.72 – 1.21)	0.600
Ethnic group	White	1544 (78.9%)	2.96 (2.17 – 4.03)	≤ 0.001	2.84 (1.93 – 4.18)	≤ 0.001
	BAME	104 (55.9%)	Ref		Ref	
Marital status	Married or cohabiting	1057 (78.9%)	1.36 (1.10 – 1.69)	0.005	1.14 (0.87 – 1.49)	0.346
	Other	486 (73.3%)	Ref		Ref	
Children (≤ 18 years) living in the household	Yes, or sometimes	581 (76.2%)	0.95 (0.77 – 1.17)	0.610	1.08 (0.82 – 1.40)	0.593
	No	1071 (77.2%)	Ref		Ref	
Adults (≤ 70 years) living in the household	Yes, or sometimes	521 (75.8%)	0.92 (0.74 – 1.13)	0.422	0.95 (0.74 – 1.23)	0.712
	No	1127 (77.4%)	Ref		Ref	
Employment status	Employed full /part-time	1109 (75.2%)	Ref		Ref	
	Other types of (un) employment	529 (80.3%)	1.34 (1.07 – 1.68)	0.011	1.32 (0.99 – 1.77)	0.060
Educational level	Below degree level	683 (74.2%)	0.75 (0.61 – 0.92)	0.006	0.73 (0.57 – 0.94)	0.014
	Degree level or above	906 (79.4%)	Ref		Ref	
	No formal qualifications/ other	52 (74.3%)	0.75 (0.43 – 1.31)	0.308	0.61 (0.29 – 1.30)	0.199
Smoking status	Never smoked	947 (76.8%)	1.47 (1.09 – 1.98)	0.011	1.45 (1.01 – 2.08)	0.047
	Ex-smoker	518 (80.3%)	1.81 (1.30 – 2.51)	≤ 0.001	1.49 (1.00 – 2.21)	0.049
	Current smoker	178 (69.3%)	Ref		Ref	
Health status	Mean ± SD	4.77 ± 1.48 (vs. 4.73 ± 1.45)	1.02 (0.96 – 1.09)	0.523	1.05 (0.96 – 1.15)	0.288
COVID-19 status	Not had COVID-19	1409 (77.7%)	1.33 (1.02 – 1.73)	0.033	1.28 (0.94 – 1.76)	0.122
	Has or has had COVID-19 (without or without a test)	243 (72.3%)	Ref		Ref	

High-risk group (individual)	In a high-risk group	470 (79.8%)	1.25 (0.99 – 1.59)	0.061	1.26 (0.92 – 1.71)	0.149
	Not in a high-risk group	1063 (75.9%)	Ref		Ref	
High-risk group (member of household)	In a high-risk group	408 (77.9%)	1.06 (0.83 – 1.34)	0.646	1.03 (0.78 – 1.38)	0.824
	Not in a high-risk group	1114 (76.9%)	Ref		Ref	

Key: The following response options were excluded from the univariable and multivariable analyses: other and/or prefer not to say and/or unsure.

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