The Impact of the Covid-19 Pandemic on Uptake of Influenza Vaccine: A UK-Wide Observational Study

Patrik Bachtiger, Alexander Adamson, Ji-Jian Chow, Rupa Sisodia, Jennifer K Quint, Nicholas Peters

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[1]National Heart & Lung Institute Imperial College London London GB

Corresponding Author:
Patrik Bachtiger MBBS, BSc, MRCP, MSc, MPH
National Heart & Lung Institute
Imperial College London
Hammersmith Hospital Campus
Du Cane Road
London
GB

Abstract

Background: In the face of the Covid-19 pandemic, the UK National Health Service (NHS) flu vaccination eligibility is extended this year to ~32.4 million (48.8%) of the population. Knowing intended uptake will inform supply and public health messaging to maximise vaccination.

Objective: The objective of this study was to measure how the Covid-19 pandemic will impact uptake of the UK National Health Service's (NHS) expanded flu vaccination programme, and to inform reasons for or against vaccination.

Methods: Intention to receive influenza vaccine in 2020-21 was asked of all registrants of the NHS's largest electronic personal health record. Of those who were either newly or previously eligible but had not previously received influenza vaccination, multivariable logistic regression, and network analysis were used to examine reasons to have or decline vaccination.

Results: Among 6,641 respondents, 945 (14.2%) were previously eligible but not vaccinated of whom 536 (56.7%) intend to receive flu vaccination in 2020/21, as do 466 (68.6%) of the newly eligible, increasing nationwide vaccination demand by ~50%. Intention to receive the flu vaccine was associated with increased age, index of multiple deprivation (IMD) quintile, and considering oneself at high risk from Covid-19. Among those eligible but intending not to be vaccinated in 2020/21, 164 (30.2%) gave misinformed reasons. 47 (49.9%) of previously unvaccinated healthcare workers will decline vaccination in 2020/21.

Conclusions: In this sample, Covid-19 has increased acceptance of flu vaccination from 79.6% to 91.2% in those previously eligible, and 69% in the newly eligible. Meeting this demand for flu vaccination of ~26 million of the UK population is 50% higher than last year. This study is essential for informing resource planning and the need for effective messaging campaigns to address negative misconceptions, a strategy also necessary for Covid-19 vaccination programmes.

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Patrik Bachtiger[1,2], MRCP MSc MPH; Alex Adamson[1], MSc; Ji-Jian Chow[1,2], MRCP MA; Rupa Sisodia[1], BSc; Jennifer K Quint[1,2], FRCP MSc PhD; Nicholas S Peters[1,2], FRCP MD

1. National Heart & Lung Institute, Imperial College London, UK
2. Imperial College Healthcare NHS Trust, London, UK

PB: Clinical Research Fellow
AA: Medical Statistician
JJC: Clinical Research Fellow
RS: Research Assistant
JKQ: Professor of Respiratory Epidemiology, Honorary Consultant Physician in Respiratory Medicine
NSP: Professor of Cardiology, Honorary Consultant Cardiologist

Corresponding author:
Professor Nicholas S Peters
National Heart & Lung Institute
Imperial College London
Hammersmith Campus
WC12 0HS, London, UK
n.peters@imperial.ac.uk

Key words: Covid-19; influenza; flu; vaccination

ABSTRACT:

Background:
In the face of the Covid-19 pandemic, the UK National Health Service (NHS) flu vaccination eligibility is extended this season to ~32.4 million (48.8%) of the population. Knowing intended

uptake will inform supply and public health messaging to maximise vaccination.

Objective:

The objective of this study was to measure the impact of the Covid-19 pandemic on acceptance of flu vaccination in the 2020-21 season, specifically focusing on those previously eligible who routinely decline vaccination and the newly eligible.

Methods:

Intention to receive influenza vaccine in 2020-21 was asked of all registrants of the NHS's largest electronic personal health record by online questionnaire on 31st July 2020. Of those who were either newly or previously eligible but had not previously received influenza vaccination, multivariable logistic regression and network diagrams were used to examine reasons to have or decline vaccination.

Findings:

Among 6,641 respondents, 945 (14.2%) were previously eligible but not vaccinated, of whom 536 (56.7%) intended to receive flu vaccination in 2020/21, as did 466 (68.6%) of the newly eligible. Intention to receive the flu vaccine was associated with increased age, index of multiple deprivation (IMD) quintile, and considering oneself at high risk from Covid-19. Among those eligible but intending not to be vaccinated in 2020/21, 164 (30.2%) gave misinformed reasons. 47 (49.9%) of previously unvaccinated healthcare workers would decline vaccination in 2020/21.

Conclusions:

In this sample, Covid-19 has increased acceptance of flu vaccination in those previously eligible but unvaccinated and motivates substantial uptake in the newly eligible. This study is essential for informing resource planning and the need for effective messaging campaigns to address negative misconceptions, also necessary for Covid-19 vaccination programmes.

INTRODUCTION:

The coronavirus disease 2019 (Covid-19) pandemic has thus far led to over 100,000 deaths in the UK alone. With increasing regional outbreaks,[1] substantial concern has been raised about preparedness for a nationwide escalation of cases throughout winter pressures in 2020/21.[2-4] Seasonal influenza (flu) puts the UK National Health Service (NHS) under considerable pressure each winter with up to 18,000 additional daily emergency admissions,[5] and >4,000 hospital beds occupied daily by patients with flu in 2017/18.[6,7]

For this reason, the NHS has extended its free seasonal flu vaccination programme this season to all

over 50s (previously 65), and to include the 11-12 age group (previously 2-10s),[8] now making an estimated 32.4 million (48.8%) of the UK population eligible.[9] In England in 2019, uptake of the flu vaccine among those eligible was only 70.6%,[10] below the critical 75% target for effectiveness recommended by the World Health Organisation (WHO).[11] On a background of declining numbers over the last decade (from 74.2% high in 2008-9), uptake this season is not only unknown but completely unpredictable. The threat of Covid-19 and the associated publicity educating the public about viruses and vaccine development, coupled with recent evidence that co-infection with influenza and SARS-CoV-2 doubles mortality compared with infection with Covid-19 alone,[12] and that the flu vaccination may reduce incidence of life-threatening Covid-19 disease in the over 65 group,[13] are likely to affect attitudes and the public health imperative of mass uptake. With substantial concerns that higher earlier uptake of flu vaccination in 2020/21 will rapidly deplete stocks (already reported[14]) there is yet again a threat of a lack of informed planning resulting in failure to meet the demands of a public health initiative.

Therefore, the objective of this study was to measure the impact of the Covid-19 pandemic on acceptance of flu vaccination in the 2020-21 season, specifically focusing on those previously eligible (over 65s or eligible comorbidity) who routinely decline vaccination and the newly eligible (50-64 year-olds) – two groups where determinants of vaccine hesitancy may differ. These groups include those at highest risk from Covid-19; if the flu vaccine confers a reduced risk of this, understanding specific covariates that relate to vaccine hesitancy can inform public health messaging to maximise uptake and help contend with potential double winter pandemics of flu and Covid-19.

METHODS:

Study Participants

Participants were registrants of the Care Information Exchange (CIE) of Imperial College Healthcare NHS Foundation Trust. The CIE is the UK's largest patient-facing electronic health record, accessible by email registration for any patient who has had an encounter at the Trust (UK wide population, Supplementary Figure 1). On the 5th of June 2020 the CIE held 57,056 registrants, of whom 34,502 were 'active' users, defined as one or more logins in the preceding month.

Participants in this study were CIE registrants receiving weekly online questionnaires through the platform, starting 9th April 2020 (week 1), as a direct care tool for self-monitoring physical, mental and social wellbeing during the Covid-19 pandemic. This was the first ever such use of the CIE platform, prompted by the immediate public health priorities to provide patients with a tool to track their wellbeing and inform local and national health policy through this exercise in participatory

epidemiology.

Questionnaire Design & Timing

A questionnaire including items on the government's expanded flu vaccination programme was sent to participants on 31st July 2020 (week 16, Supplementary Table 1). Applying recommendations for questionnaire design,[15,16] question items were developed by a collaboration of experts in qualitative research at Imperial College London, encompassing public health, respiratory epidemiology and digital health, and were also informed by previous studies.[17,18] Question items were externally peer-reviewed and tested on lay persons (n = 5) before being included. The focus was on previous uptake of flu vaccination, being for or against vaccination in 2020/21 and reasons why (unrestricted free text responses), health worker status and presence of school-age children in the household. Responses from participants regarding the presence of school age children in their household were also recorded. Specifically, and, if offered, whether they would want any of these children to receive flu vaccination in 2020/21. It could not be assumed that those vaccinated last year would continue this habit. Subsequently, a specific question was posed in order to also measure if any participants vaccinated in 2019/20 would not do so again in 2020/21.

Responses to items in prior questionnaires in the series were used to complete information on participant ethnicity, additional vaccine eligibility criteria (including chronic disease), index of multiple deprivation (IMD) quintile (obtained from participant postcode), healthcare utilisation since beginning of lockdown, whether the participant considered themselves at high risk from Covid-19, experience of any Covid-19 symptoms, self-reported understanding of government advice, anxiety related to a return to lockdown, and whether the participant would agree to receive a Covid-19 vaccine if available.

Inclusion and Exclusion Criteria

Participants were aged 18 or above and must have answered questionnaires capturing variables relevant to the analysis (see Figure 1 flow diagram) and answered 'no' to a question assessing whether they routinely received flu vaccination. Respondents not eligible for flu vaccination (i.e. age<50) were excluded. Participants submitting incomplete or inconsistent responses to the questions on flu vaccination were excluded, as were those who answered 'prefer not to say' for ethnicity and who were missing responses for other variables required in the analysis, with the exception of post-code. Responses submitted later than four days from the time of the questionnaire launch were excluded.

Figure 1. Participant inclusion flow diagram based on responses to questionnaires capturing variables required for analysis.
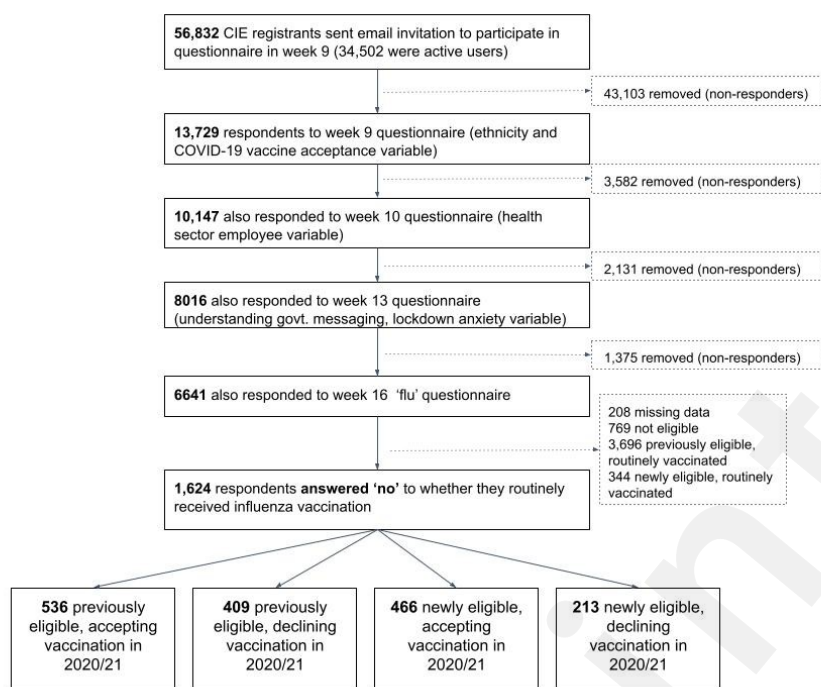
Definition of Study Groups

The analyses in this study were confined to those participants eligible for free NHS flu vaccination in 2020/21 who indicated they had previously not routinely received it (this group is the greatest unknown for planning resourcing and targeting public health campaigns to maximise uptake). This previously unvaccinated group were either previously eligible (main criteria up to 2019/20 were age over 65, eligible comorbidity and working in the healthcare sector), or newly eligible for the expanded 2020/21 programme (age over 50).

Further stratification according to whether or not the flu vaccine would be accepted in 2020/21 generated four groups: 1.) Previously eligible, newly responding 'yes', 2.) Previously eligible, still responding 'no', 3.) Newly eligible, responding 'yes', and 4.) Newly eligible, responding 'no'. Owing to inherent differences in age and comorbidity status of the previously and newly eligible cohorts, covariates for willingness to receive flu vaccine may be different and therefore this stratification is maintained throughout our analyses.

Data analysis

Age was categorised into age bands of 18-29, 30-39, 40-49, 50-59, 60-69 and 70+ to allow for easier interpretation of a potential non-linear relationship between age and responses to flu vaccination. The 10-point scale measurements of 'anxiety related to return to lockdown' and 'understanding of government messaging' were re-grouped into categories of 1-2, 3-4, 5-6, 7-8, and 9-10, and ethnicity was categorised into five groups due to low numbers in some categories. Descriptive statistics are reported for the dataset broken down according to study groups. Differences in categorical variables were assessed by chi-square tests or Fisher's exact test where chi-square test assumptions were violated, and differences in continuous variables were assessed using t-tests. P values <.05 were considered statistically significant.

The effect of variables of interest on inclination to receive a flu vaccination were calculated using univariate and multivariable logistic regression models, with presentation of both to identify if results in the univariate analysis may be due to confounding by other collected variables. The relationship between age (the only continuous variable) and the log-odds of receipt of flu vaccination were plotted and visually inspected. If the effect appeared linear, age was included as a linear variable, otherwise it was included as a categorical variable. All data were analysed in R version 3.6.2. Variables with low numbers in categories were not included in the multivariable analyses. 'Acceptance of Covid-19 vaccine if available' was deemed likely to be highly correlated with 'accepting flu vaccine in 2020/21' and was not included in multivariable models to allow greater interpretation of other predictors. Multi-collinearity was assessed by calculation of the variance inflation factor (VIF), with variables with a VIF >5 (indicating substantial multicollinearity) removed from the model.

Each participant not routinely receiving flu vaccination – previously or newly eligible – was asked to qualify their yes/no response to whether they would accept it in 2020/21 using a free text response option. Three researchers, blinded to the response on vaccine acceptance, each independently coded the content of 100 responses according to multiple prospectively identified themes that could co-occur. A consensus was then reached to define the main themes for coding the remaining responses. For example, "I don't see the point because I've never had flu" was coded as "unnecessary" and "not had flu before." A full list of the themes with examples is available in Supplementary Table 2.

Using this codified qualitative data, a network diagram,[20,21] was generated for each one of the four groups using the Networkx package in Python (version 3.7). Dimensions of centrality and overall topography of nodes was not applicable; thus the network was laid out in a comprehensible circular 'shell' arrangement. Each diagram was limited to the ten most represented themes within each group's responses. Nodes were colour coded to reflect positive, negative and neutral sentiment of themes. Separately, reasons for healthworker's continued non-vaccination in 2020/21 were reported descriptively.

RESULTS:

Among respondents aged ≥18, 6,641 completed the week 16 questionnaire on flu vaccination in the predefined time period and the requisite previous questionnaires to complete baseline characteristics (figure 1). Of these, 208 (3.1%) were missing answers to one or more essential variables and were removed, to leave 6,433 complete responses. The total number of previously eligible but unvaccinated (N=945) and newly eligible but unvaccinated (N=679) participants was 1,624 (see Figure 1 for detail).

Of vaccinated and unvaccinated previously eligible participants, those who had previously declined vaccination were more likely to be younger (median age 61 years, IQR 51 to 67 vs median age 67 years, IQR 58 to 73, p<.001), female (55.0% vs 46.7%, p<.001), have chronic neurological disease (10.8% vs 6.5%, p<.001), work in the health sector (10.2% vs 7.8%, p=.020) and be in a lower IMD quintile, p=.031, and were less likely to have chronic respiratory disease (14.5% vs 20.5%, p<.001) or chronic heart disease (7.0% vs 12.2%, p<.001) compared to those who were previous eligible and received the vaccine. Of the newly eligible participants, when compared with those who had received the vaccine despite being ineligible by NHS criteria, those who had not received the vaccine were more likely to be younger (mean age 57, IQR 54 to 61 vs median age 59, IQR 55 to 63) and in a lower IMD quintile (Supplementary Table 3). Among all respondents who indicated having received

the flu vaccine in 2019/20, 309 (4.5%) responded they did not intend to repeat this in 2020/21.

Change in Acceptance and Uptake of flu Vaccine in 2020/2021

Summary statistics for groups broken down according to vaccine eligibility and acceptance of the flu vaccine in 2020/21 are shown in Table 1. Of those previously eligible but routinely not vaccinated, 536 (56.7%) intended to be vaccinated in 2020/21, increasing the vaccination rate in the entire previously eligible cohort from 79.6% to 91.2%. Among the newly eligible, 466 (68.6%) reported they would accept vaccination in 2020/21

Table 1: Study participants (n = 1,624) from UK-wide responses to online questionnaires administered through CIE (flu related questionnaire sent 31st July 2020). Baseline demographics and questionnaire responses grouped by previously eligible but non-vaccinated and newly eligible, further stratified by acceptance (yes/no) of flu vaccination in 2020/21.

		All participants previously not routinely receiving flu vaccination, grouped by eligibility (previously or newly) and response to accepting flu vaccination (yes/no) in 2020/21			
		Previously eligible and plans to receive the flu vaccine	Previously eligible and does NOT plan to receive the flu vaccine	Newly eligible and plans to receive the flu vaccine	Newly eligible and does NOT plan to receive the flu vaccine
Total N (%)		536 (56.7)	409 (43.3)	466 (68.6)	213 (31.4)
Age	Median (IQR)	62.0 (51.0 to 67.0)	60.0 (49.0 to 68.0)	58.0 (55.0 to 61.8)	56.0 (53.0 to 60.0)
Sex	Male	248 (46.3)	177 (43.3)	214 (45.9)	69 (32.4)
	Female	288 (53.7)	232 (56.7)	252 (54.1)	144 (67.6)
Ethnicity	White	453 (84.5)	320 (78.2)	415 (89.1)	181 (85.0)
	Asian	36 (6.7)	39 (9.5)	19 (4.1)	13 (6.1)
	Black	15 (2.8)	20 (4.9)	13 (2.8)	9 (4.2)
	Mixed	8 (1.5)	6 (1.5)	6 (1.3)	2 (.9)
	Other	24 (4.5)	24 (5.9)	13 (2.8)	8 (3.8)

Eligible disease **Yes**		368 (68.7)	282 (68.9)	-	-
Chronic respiratory disease		71 (13.2)	66 (16.1)	-	-
Chronic heart disease		40 (7.5)	26 (6.4)	-	-
Chronic kidney disease		25 (4.7)	23 (5.6)	-	-
Chronic liver disease		15 (2.8)	11 (2.7)	-	-
Chronic neurological disease		48 (9.0)	54 (13.2)	-	-
Immunocompromised		196 (36.6)	137 (33.5)	-	-
Other eligible co-morbidity		103 (19.2)	93 (22.7)	-	-
Health sector employee		47 (8.8)	49 (12.0)	-	-
Index of multiple deprivation (IMD)	**1**	34 (6.3)	31 (7.6)	17 (3.6)	14 (6.6)
	2	78 (14.6)	64 (15.6)	69 (14.8)	36 (16.9)
	3	107 (20.0)	59 (14.4)	94 (20.2)	29 (13.6)
	4	85 (15.9)	55 (13.4)	87 (18.7)	28 (13.1)
	5	79 (14.7)	44 (10.8)	57 (12.2)	15 (7.0)
	(Missing)	153 (28.5)	156 (38.1)	142 (30.5)	91 (42.7)
Healthcare utilisation	**None**	91 (17.0)	89 (21.8)	145 (31.1)	80 (37.6)
	Any	445 (83.0)	320 (78.2)	321 (68.9)	133 (62.4)
Considering self at high risk from Covid-19		346 (64.6)	267 (65.3)	140 (30.0)	41 (19.2)
Understanding of government messaging	**5-6**	138 (25.7)	93 (22.7)	107 (23.0)	53 (24.9)
	1-2	31 (5.8)	34 (8.3)	48 (10.3)	16 (7.5)
	3-4	69 (12.9)	48 (11.7)	65 (13.9)	24 (11.3)
	7-8	190 (35.4)	133 (32.5)	159 (34.1)	72 (33.8)
	9-10	108 (20.1)	101 (24.7)	87 (18.7)	48 (22.5)
Anxiety related to	**5-6**	149 (27.8)	111 (27.1)	127 (27.3)	48 (22.5)

return to lockdown				
	1-2	87 (16.2)	85 (20.8)	76 (16.3)	50 (23.5)
	3-4	90 (16.8)	59 (14.4)	85 (18.2)	35 (16.4)
	7-8	150 (28.0)	105 (25.7)	130 (27.9)	50 (23.5)
	9-10	60 (11.2)	49 (12.0)	48 (10.3)	30 (14.1)
Acceptance of Covid-19 vaccine if available	Not sure	100 (18.7)	159 (38.9)	72 (15.5)	85 (39.9)
	No	35 (6.5)	117 (28.6)	25 (5.4)	38 (17.8)
	Yes	401 (74.8)	133 (32.5)	369 (79.2)	90 (42.3)

Differences in categorical variables assessed using Chi-squared tests, unless marked by '' indicating that assumptions were violated and Fisher's exact test was used. Differences in continuous variables assessed using t-tests.*

Predictors of Willingness to Receive Flu Vaccination

In the univariate analysis (tables 2 and 3), willingness to receive a Covid-19 vaccine was associated with willingness for flu vaccination in 2020/21 in both groups compared to those who were unsure (OR = 4.79, 95%CI 3.50 to 6.61, OR = 4.84, 95% CI 3.29 to 7.17). 74.8% and 79.2% of those who would newly accept flu vaccination who were previously eligible and newly eligible responded they would accept a Covid-19 vaccination, compared to 32.5% and 42.3% of those declining the flu vaccine.

In those who were previously eligible, answering 'no' in response to receiving a Covid-19 vaccination if offered was associated with a lower likelihood of wanting to receive the flu vaccination in 2020/21 (OR = 0.48, 95% CI 0.30 to 0.74), as was having a chronic neurological disease (OR = 0.65, 95% CI 0.43 to 0.98). Whilst those aged 60-69 were more likely to respond 'yes' than those aged 70+, (OR 1.48, 95% CI 1.02 to 2.14) there was no clear effect of age found in those below the age of 60. The multivariable analysis (tables 2 and 3) resulted in few substantial changes to effect estimates, with the exception of age, for which all estimates shifted upwards (showing a stronger association with an increased likelihood of answering 'yes' after adjustment for other variables).

In those who became newly eligible to receive the flu vaccine, there was an association between increased age (OR for 1-year increase in age = 1.07, 95% CI 1.03 to 1.12), IMD quintile, and considering oneself at high risk from Covid-19 (OR = 1.80, 95% CI 1.22 to 2.70) and answering 'yes' to receiving the flu vaccine if offered. Females were less likely to answer 'yes' (OR = 0.56, 95% CI 0.40 to 0.79), as were those who rated their anxiety about the lifting of lockdown as 1-2 (low anxiety) (OR = 0.57, 95% CI 0.35 to 0.93, compared to those rating it 5-6). Multivariable analysis resulted in minimal changes to the estimates, demonstrating that the univariate associations found were not due to confounding by the other variables included in the model.

Table 2 - Unadjusted and adjusted logistic regression to predict a 'yes' response for participants who would accept a flu vaccine in 2020/21 in those who were previously eligible but did not routinely

receive flu vaccination.

	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age (reference category: 70+): 18-29	**1.99 (0.85 to 5.06)**	**2.53 (1.00 to 6.89)**
30-39	**0.83 (0.46 to 1.49)**	**1.20 (0.62 to 2.31)**
40-49	**0.86 (0.54 to 1.35)**	**1.17 (0.70 to 1.95)**
50-59	**1.11 (0.75 to 1.66)**	**1.42 (0.90 to 2.25)**
60-69	**1.48 (1.02 to 2.14)**	**1.61 (1.09 to 2.37)**
Sex (female)	**0.89 (0.68 to 1.15)**	**0.93 (0.70 to 1.23)**
Ethnicity (reference category = white): Asian	**0.65 (0.40 to 1.05)**	**0.71 (0.43 to 1.18)**
Black	**0.53 (0.26 to 1.05)**	**0.58 (0.27 to 1.18)**
Mixed	**0.94 (0.32 to 2.89)**	**1.09 (0.36 to 3.50)**
Other	**0.71 (0.39 to 1.27)**	**0.71 (0.39 to 1.31)**
Comorbidity: Chronic respiratory disease	**0.79 (0.55 to 1.14)**	**0.78 (0.52 to 1.18)**
Chronic heart disease	**1.19 (0.72 to 2.00)**	**1.03 (0.60 to 1.79)**
Chronic kidney disease	**0.82 (0.46 to 1.48)**	**0.71 (0.38 to 1.33)**
Chronic liver disease	**1.04 (0.48 to 2.35)**	**0.94 (0.41 to 2.22)**
Chronic neurological disease	**0.65 (0.43 to 0.98)**	**0.62 (0.38 to 0.99)**
Immunocompromised	**1.14 (0.87 to 1.50)**	**0.95 (0.69 to 1.32)**
Other comorbidity	**0.81 (0.59 to 1.11)**	**0.79 (0.56 to 1.10)**
Health sector employee	**0.71 (0.46 to 1.08)**	**0.76 (0.46 to 1.24)**
IMD quintile (Reference category = 1): 2	**1.11 (0.62 to 2.00)**	**1.09 (0.59 to 2.01)**
3	**1.65 (0.92 to 2.96)**	**1.54 (0.84 to 2.82)**
4	**1.41 (0.78 to 2.55)**	**1.29 (0.70 to 2.40)**
5	**1.64 (0.89 to 3.02)**	**1.59 (0.84 to 3.00)**
Missing	**0.89 (0.52 to 1.53)**	**0.91 (0.52 to 1.59)**
Healthcare utilisation	**1.36 (0.98 to 1.88)**	**1.41 (0.99 to 2.01)**
Considering self at high risk from COVID-19	**0.97 (0.74 to 1.27)**	**1.03 (0.76 to 1.39)**
Understanding of government messaging (reference category = 5-6): 1-2	**0.61 (0.35 to 1.07)**	**0.59 (0.33 to 1.05)**

3-4	0.97 (0.62 to 1.53)	0.89 (0.56 to 1.43)
7-8	0.96 (0.68 to 1.36)	0.92 (0.64 to 1.31)
9-10	0.72 (0.49 to 1.05)	0.75 (0.50 to 1.11)
Anxiety related to return to lockdown (reference = 5-6): 1-2	0.76 (0.52 to 1.12)	0.90 (0.60 to 1.37)
3-4	1.14 (0.76 to 1.72)	1.14 (0.74 to 1.75)
7-8	1.06 (0.75 to 1.51)	1.07 (0.74 to 1.54)
9-10	0.91 (0.58 to 1.43)	1.06 (0.66 to 1.71)
Acceptance of COVID-19 vaccine if available (reference = "unsure"): No	0.48 (0.30 to 0.74)	-
Yes	4.79 (3.50 to 6.61)	-

Adjusted odds ratio adjusted for every other variable in model (age, sex, ethnicity, disease, IMD quintile, health care utilisation, considering oneself at high risk for COVID-19, undertaking any COVID-19 test, believing oneself to have had COVID-19, understanding of government advice, anxiety related to a return to lockdown)

Table 3 - Unadjusted and adjusted logistic regression to predict a 'yes' response for participants who would accept a flu vaccine in 2020/21 in those who were newly eligible and not routinely vaccinated anyway.

	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age	1.07 (1.03 to 1.12)	1.06 (1.01 to 1.10)
Female	0.56 (0.40 to 0.79)	0.54 (0.37 to 0.77)
Asian	0.64 (0.31 to 1.35)	0.57 (0.26 to 1.29)
Black	0.63 (0.27 to 1.55)	0.76 (0.30 to 2.01)
Mixed	1.31 (0.30 to 8.99)	0.89 (0.17 to 6.63)
Other	0.71 (0.29 to 1.82)	0.77 (0.29 to 2.17)
Other comorbidity	1.17 (0.79 to 1.76)	1.01 (0.66 to 1.59)
IMD quintile 2	1.58 (0.69 to 3.57)	1.60 (0.66 to 3.85)
IMD quintile 3	2.67 (1.17 to 6.08)	2.51 (1.02 to 6.13)
IMD quintile 4	2.56 (1.11 to 5.86)	2.63 (1.07 to 6.45)
IMD quintile 5	3.13 (1.26 to 7.86)	2.83 (1.07 to 7.59)
IMD (Missing)	1.29 (0.60 to 2.73)	1.16 (0.51 to 2.63)
Healthcare utilisation	1.33 (0.95 to 1.87)	1.45 (1.00 to 2.11)

Patient considers themself at high risk for covid-19	1.80 (1.22 to 2.70)	2.00 (1.29 to 3.16)
Understanding government messaging 1-2	1.49 (0.78 to 2.92)	1.46 0.73 to 3.02)
3-4	1.34 (0.76 to 2.40)	1.24 0.68 to 2.30)
7-8	1.09 (0.71 to 1.68)	0.98 0.62 to 1.56)
9-10	0.90 (0.55 to 1.46)	1.00 (0.59 to 1.68)
Anxiety related to return to lockdown 1-2	0.57 (0.35 to 0.93)	0.53 0.31 to 0.90)
3-4	0.92 (0.55 to 1.54)	0.95 0.55 to 1.65)
7-8	0.98 (0.62 to 1.57)	0.93 (0.57 to 1.53)
9-10	0.60 (0.34 to 1.07)	0.56 (0.30 to 1.05)
Acceptance of COVID-19 vaccine if available: No	0.78 (0.43 to 1.40)	-
Acceptance of COVID-19 vaccine if available: Yes	4.84 (3.29 to 7.17)	-

Adjusted odds ratio adjusted for every other variable in model (age, sex, ethnicity, disease, IMD quintile, health care utilisation, considering oneself at high risk for COVID-19, undertaking any COVID-19 test, believing oneself to have had COVID-19, understanding of government advice, anxiety related to a return to lockdown)

Subgroup Analyses of Healthcare Workers and Households with Schoolchildren

In the cohort of previously unvaccinated healthcare workers, 49 (51.0%) of previously unvaccinated healthcare workers would accept the flu vaccine in 2020/21, compared to 47 (49.9%) who would continue to decline. The question items pertaining to flu vaccination of school children was answered by 1419 (87.4%) participants. Among these, 150 responded they had school children in their household and answered 'yes' or 'no' to whether they would want any children to be vaccinated in 2020/21 if offered. Among the 71 participants who were previously eligible but not routinely vaccinated, 33 (82.5%) of those who would accept vaccination in 2020/21 would also vaccinate children, compared to 8 (25.8%) of those who would not accept the flu vaccine for themselves (Fisher's exact test p<.001). Among the 79 participants who were previously unvaccinated and newly eligible in 2020/21, 46 (82.1%) of those who would get a flu vaccine this year would want their child to have it also, compared to 10 (43.5%) of those who would not get the flu vaccine for themselves (Fisher's exact test p = .001).

Network diagram of reasons for or against vaccination

A free text response qualifying why participants would/would not accept flu vaccination in 2020/21 was submitted by 834 (88.3%) from the previously eligible, unvaccinated and 619 (91.2%) of the newly eligible group. These were coded according to 45 themes (full list in supplementary table 2). Figure 2 displays network diagrams for the ten most common themes for each group.

Among the previously eligible and newly eligible, the three most frequent themes among those newly accepting flu vaccination in 2020/21 were 'precaution for myself' 197 (41.2%), 'Covid-19' 131 (27.4%), and 'health reasons' 76 (15.9%), and 'precaution for myself' (199, 46.1%), 'Covid-19' (117, 27.1%) and 'age' (103, 23.9%), respectively; 'precaution for myself' was qualified by 'Covid-19' in 71 (36.0%) and 58 (29.1%) participants.

For the previously and newly eligible group declining vaccination, the three most frequent themes were 'unnecessary' (88, 24.7%), 'vaccine doesn't work' (53, 14.9%), and 'makes me unwell', and 'unnecessary' (87, 46.5%), 'not had flu before' (30, 16.0%) and 'vaccine doesn't work' (19, 10.2%), respectively.

Reasons for continued non-vaccination among healthcare workers

Eighty-nine (85.6%) healthcare workers reporting previous non-vaccination submitted qualifying responses, among whom 47 were from those newly accepting and 42 continuing to decline in 2020/21. For the former, 'precaution for myself' (17, 36.2%), 'Covid-19' (16, 34.0%) and 'health reasons' (8, 17.0%) were most cited. In those continuing to decline, most frequent reasons were 'gives me flu' (10, 23.8%), 'vaccine doesn't work' (8, 19.0%) and 'unnecessary' (6, 14.3%).
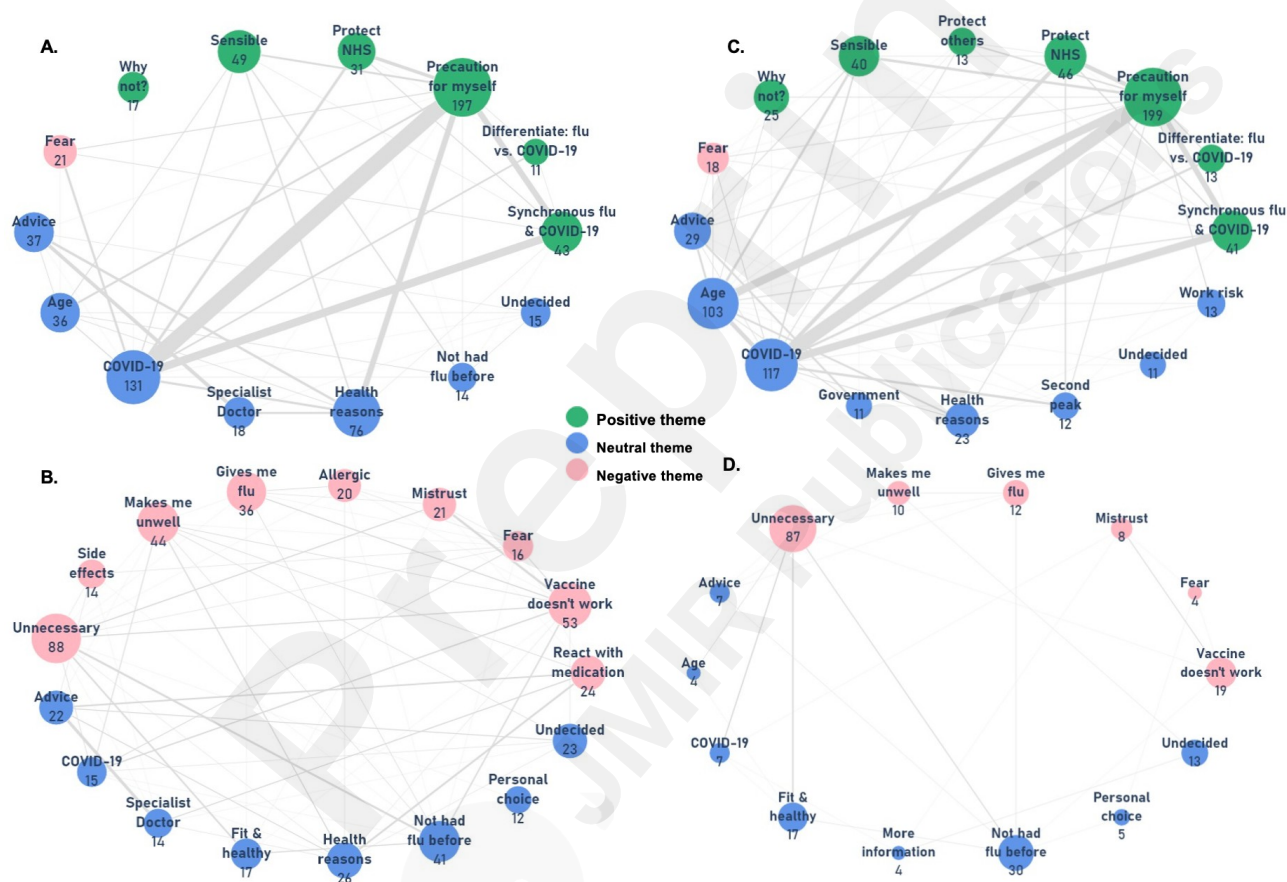
Figure 2. Study participants (n = 1,624) from UK-wide responses to online questionnaires administered through CIE (flu related questionnaire sent 31st July 2020), network diagram of free-text responses (n = 1,453, 89.5%). Responses from previously eligible respondents who had previously not accepted the flu vaccine but would accept it in 2020/21 (A; n = 478), or continue to decline (B; n = 356); responses from newly eligible participants who would accept vaccination (C; n = 432) or decline (D; n = 187). Colour-coded sentiment of nodes where green = positive, red = negative, blue = neutral. A connecting line (edge) between nodes implies at least one response where themes of connected nodes co-occurred; the thickness of the line corresponds to the frequency of co-occurrence.

DISCUSSION:

The threat of Covid-19 and the associated publicity educating the public about viruses and vaccine development mean that following a decade of declining numbers, uptake of the flu vaccine this year is both unknown and unpredictable. With early reports that higher uptake of flu vaccination will rapidly deplete stocks,[14] there is yet again a threat of a lack of informed planning resulting in failure to meet the demands of a public health initiative. Our findings, including that >90% of previously and 70% of newly eligible participants want vaccination, provide strong evidence to inform planning and public health messaging to maximise vaccination.

The finding that co-infection doubles the risk of death[12] was published after collection of the data described in this study; nonetheless, our results indicate that specifically avoidance of 'synchronous flu and Covid-19' and 'differentiating flu vs. Covid-19' were already motivators for new flu vaccine uptake for the 2020/21 season. This suggests that the UK public already perceived the risk from a convergence of both viruses. Indeed, in this study, increasing age, IMD and higher levels of anxiety were associated with increased likelihood of accepting vaccination among the newly eligible, but the strongest association was considering oneself at high risk from Covid-19, associated with an 80% increase in uptake. This relates to our observation in the network diagram that the common reason 'precaution for myself' was frequently qualified by 'Covid-19' in both of the groups accepting vaccination. Among those not accepting vaccination, the newly eligible appear to be predominantly motivated by a belief that vaccination is 'unnecessary', contrasting with the previously eligible who gave substantially more misinformed reasons e.g., 'gives me flu', presumably by virtue of more experience and exposure to vaccination and therefore more time to develop misinformed beliefs.

Our finding that the previously eligible but unvaccinated in the 60-69 age group were 50% more likely to respond 'yes' to vaccination in 2021 than those age 70+ is perhaps unsurprising, given the latter are at highest risk if exposed — i.e., by leaving home to receive a flu vaccine — to Covid-19. The observation that chronic neurological disease was associated with more vaccine hesitancy may be explained by patients receiving specific therapy (such as for multiple sclerosis) contraindicating flu vaccination.

The UK's childhood flu vaccination has never reached its 65% uptake target (60.8% in 2018-19)[19], and our study suggests part of the narrative around unvaccinated children is that adults in their household may also be hesitant to have a flu vaccine for themselves. Perhaps more concerning is that children may assume their parents' attitudes to vaccination in later life.[20] Public trust is critical for confidence in vaccination programmes,[21,22] which must be underpinned by clear messaging campaigns, particularly relevant for the newly eligible who, as shown in our study, express fewer misinformed views around the flu vaccine. Media coverage in the current global health crisis has led to an unprecedented level of education of the general public on respiratory viruses and vaccine development and associated trust in scientific reporting.[23,24] Nonetheless, social media is potentially damaging by proliferating misinformation.[25] Collectively, misinformed themes of

'makes me unwell', 'gives me flu' and 'vaccine doesn't work' were present across 35.1% and 20.9% of responses in unvaccinated previously and newly eligible, respectively. Governmental messaging campaigns to address misconceptions such as these are doubly important because they have the potential not only to increase uptake of the flu vaccine, but also prevent these same misconceptions undermining uptake of a future Covid-19 vaccine. Transparency in how a vaccine is being developed must be accompanied by assurances that safety and efficacy are critical and the avoidance of a problematical vaccine diminishing public trust.[26]-

This study suggests that the UK population continues to feel a sense of duty to the NHS; 8.5% of those newly accepting vaccination cited 'protect the NHS' as their reason. Such messaging, as was used to encourage adherence to the government's 'stay at home' policy during the height of the first wave of the pandemic,[27] could also be leveraged to increase uptake of flu and Covid-19 vaccines. It is noteworthy in the context of the general public's motivation to protect the NHS, 50% of healthcare professionals in this sample who refused the flu vaccine previously still do not intend to have it. Confirmation of this requires further study of larger cohorts of such professionals.

This study has several limitations. These results are only indicative; whether participants stick to their response when faced with flu vaccination is uncertain. Intentionality may not always translate to actual vaccine uptake. Though one study of US adults aged over 18 suggested just over half of those who declared intending to receive a flu vaccine followed through,[28] follow-through in our study's over 50s population is likely to be significantly higher.[29] The advantage of this study using the NHS' CIE to collect responses is an inherent ability to link to both primary and secondary care data, thereby enabling us to further progress this work at the end of the 2020-21 flu season by measuring how intentionality translated to actual uptake.

Use of the CIE, to which all participants were registered, implies both a higher disease burden and better agency over one's health, and notably the previously eligible population had a higher baseline uptake (79.6%) than last year's national average (70.6%). This is more broadly indicative of a sample that is not fully representative of the general population, though our data do suggest some of the lower IMD quintiles were adequately captured. Despite representative distribution of questionnaires, ethnic minorities were under-represented in the respondents, limiting the generalisability of acceptance rates and their reasons for and against new uptake. Our study could not fully consider potential mismatches between those eligible for flu vaccination and those at highest risk of serious Covid-19. By also examining changes in vaccine hesitancy in those ineligible for flu vaccination but nonetheless at higher risk of Covid-19, e.g. non-morbidly obese[30] we could inform policy for further extension of the flu vaccine criteria to include such individuals. The time-sensitive need to accumulate these data prohibited the generation of question items using, for example, in-depth Delphi methods and full psychometric evaluation of validity, but an expert team including patient representation designed the questionnaire.

CONCLUSION:

In this sample, the Covid-19 pandemic has influenced increased acceptance of flu vaccination in 2020/21 in those previously eligible but routinely unvaccinated, and is also a major driver of acceptance among the newly eligible. This high anticipated demand requires appropriate planning, but can be further increased with effective messaging campaigns to address negative misconceptions about flu vaccination, which may also help prepare for future Covid-19 vaccination. Maximising vaccination requires informed planning of vaccine supply and public health messaging if we are to avoid failure once again of an essential public health response to the Covid-19 pandemic this winter.

Competing interests: All authors have completed the [Unified Competing Interest form](#) (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Author Contribution:

Patrik Bachtiger: study design, data collection, literature review, data analysis, figures, writing
Alexander Adamson: study design, literature review, figures, data analysis, writing
Ji-jian Chow: figures, data analysis, writing
Rupa Sisodia: figures, data analysis, writing
Jennifer K Quint: study design, literature review, data analysis, figures, writing
Nicholas S Peters: study design, data collection, literature review, data analysis, figures, writing

NSP is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Ethical approval: The weekly questionnaire was a direct care tool for patients to self-monitor their wellbeing during the Covid-19 pandemic. Participants were not paid or otherwise compensated for completing questionnaires. Review by the Imperial College Healthcare NHS Trust Data Protection Office advised ethical approval for data analysis and publication was not required. Participants gave informed consent within the CIE, were free to opt-out of receiving questionnaires at any time,, and were informed prior to completing responses that these would be fully anonymised and stored on secure servers before analysis – towards informing local and national health policy.

Dissemination to participants and related patient and public communities: We plan to disseminate these findings to participants in our Trust's annual online newsletter.

Data availability: Imperial College Healthcare NHS Trust is the data controller. The datasets analysed in this study are not publicly available but can be shared for scientific collaboration subject to meeting requirements of the institution's data protection policy.

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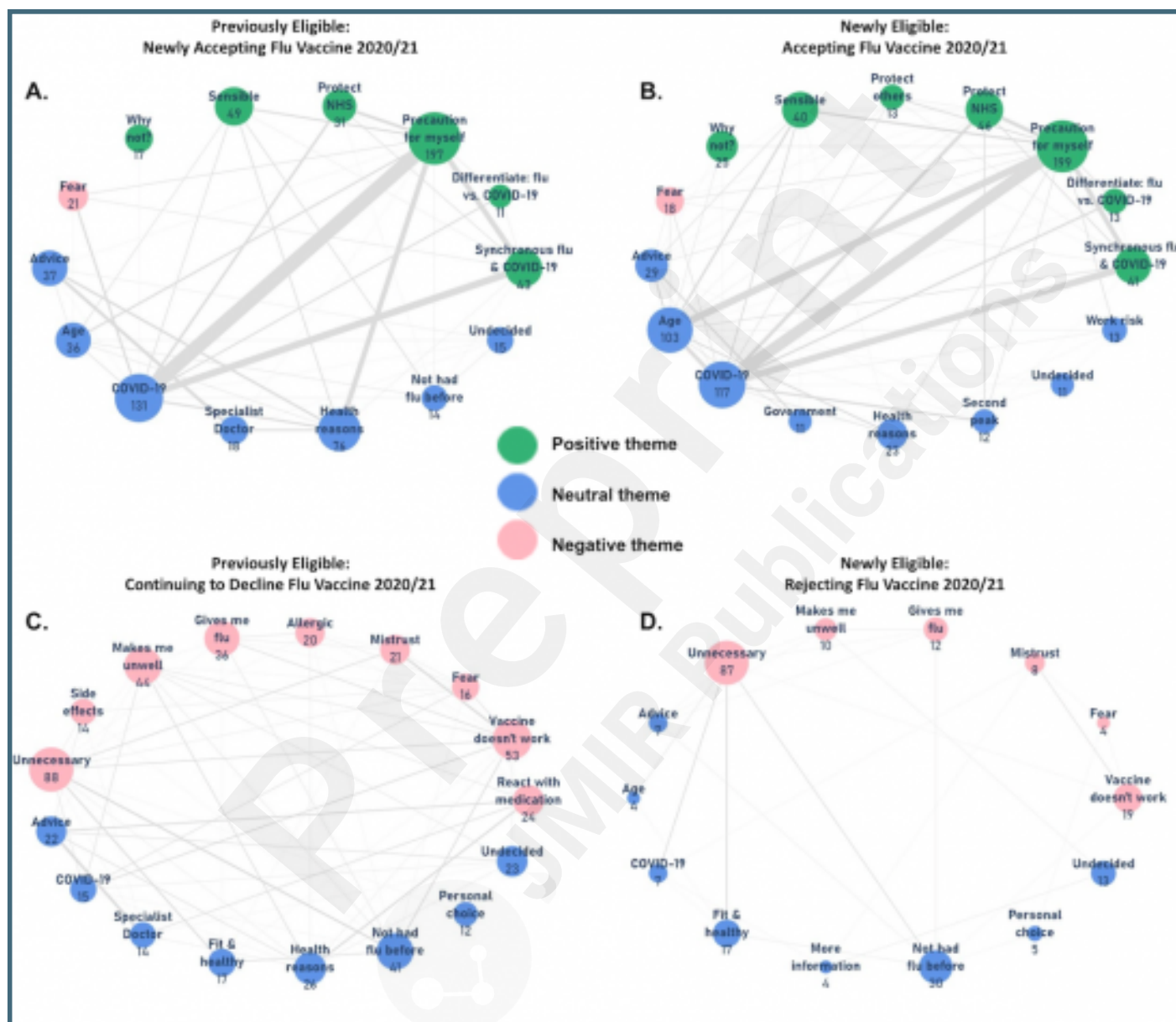
Supplementary Files

Figures

Participant inclusion flow diagram based on responses to questionnaires capturing variables required for analysis.
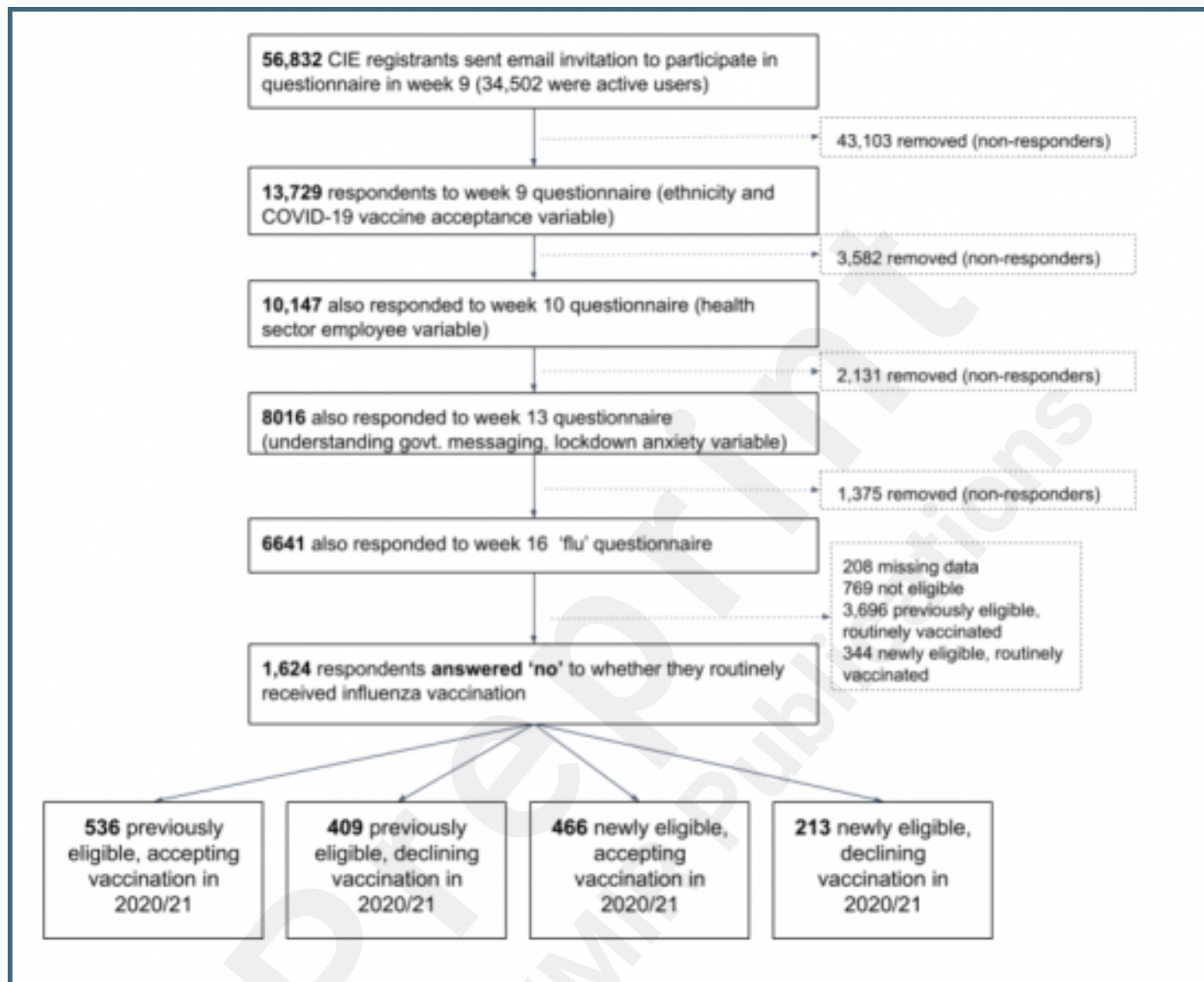
Network diagram of free-text responses (n = 1,453, 89.5%) recorded 31st July through CIE questionnaire. Responses from previously eligible respondents who had previously not accepted the flu vaccine but would accept it in 2020/21 (A; n = 478), or continue to decline (B; n = 356); responses from newly eligible participants who would accept vaccination (C; n = 432) or decline (D; n = 187). Colour-coded sentiment of nodes where green = positive, red = negative, blue = neutral. A connecting line (edge) between nodes implies at least one response where themes of connected nodes co-occurred; the thickness of the line corresponds to the frequency of co-occurrence.

Multimedia Appendixes

Supplementary appendix.
URL: https://asset.jmir.pub/assets/87ed38505239852d186454adf233e6a2.docx

CONSORT (or other) checklists

Untitled.
URL: https://asset.jmir.pub/assets/44c4faf52cf3cbe3eacbed8f74ae2ba3.pdf