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Perceptions and behavioural responses of the general public during the early phase of the COVID-19 pandemic: A cross-sectional survey of UK Adults

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Keywords: COVID-19, novel coronavirus, epidemic, behavioural response, risk perceptions

ABSTRACT

Objective: To examine risk perceptions and behavioural responses of the UK adult population during the early phase of the COVID-19 epidemic in the UK.

Design: A cross-sectional survey

Setting: Conducted with a nationally representative sample of UK adults within 48 hours of the UK Government advising the public to stop non-essential contact with others and all unnecessary travel.

Participants: 2,108 adults living in the UK aged 18 years and over. Data were collected between March 17 and 18 2020.

Main outcome measures: Descriptive statistics for all survey questions, including the number of respondents and the weighted percentages. Logistic regression was used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) willingness and (4) ability to self-isolate.

Results Overall, 1,992 (94.2%) respondents reported taking at least one preventive measure: 85.8% washed their hands with soap more frequently; 56.5% avoided crowded areas and 54.5% avoided social events. Adoption of social-distancing measures was higher in those aged over 70 compared to younger adults aged 18 to 34 years (aOR:1.9; 95% CI:1.1 to 3.4). Those with the lowest household income were six times less likely to be able to work from home (aOR:0.16; 95% CI:0.09 to 0.26) and three times less likely to be able to self-isolate (aOR:0.31; 95% CI:0.16 to 0.58). Ability to self-isolate was also lower in black and minority ethnic groups (aOR:0.47; 95% CI:0.27 to 0.82). Willingness to self-isolate was high across all respondents.

Conclusions The ability to adopt and comply with certain NPIs is lower in the most economically disadvantaged in society. Governments must implement appropriate social and economic policies to mitigate this. By incorporating these differences in NPIs among socio-economic subpopulations into mathematical models of COVID-19 transmission dynamics, our modelling of epidemic outcomes and response to COVID-19 can be improved.

Keywords: COVID-19, novel coronavirus, epidemic, pandemic, behavioural response, risk perceptions

Article Summary

Strengths and limitations of this study

- Nationally representative sample of the UK adult population
- Quick data collection during a rapidly evolving public health emergency
- Timeliness in relation to changing government response and recommendations
- The online approach excludes those without internet access
- Collecting self-report data are generally subject to limitations including honesty, introspective ability and interpretation of the questions.

Introduction

On 31 December 2019, Chinese authorities notified the World Health Organisation (WHO) of an outbreak of pneumonia in Wuhan City, which was later classified as a new disease: COVID-19 [1]. Following identification of cases in countries outside China, on 30 January 2020, WHO declared the outbreak of COVID-19 a "Public Health Emergency of International Concern"[1]. In the UK, the first cases of COVID-19 were diagnosed at the end of January 2020, and community transmission was reported a few weeks later [2,3]. Government measures to control the epidemic were first announced on 22 January 2020 and included travel advice, information for those returning from affected countries, testing of suspected cases, isolation and contact tracing. This was followed in early February by a public health information campaign advising people to adopt hygiene measures to protect themselves and others, including more frequent handwashing with soap and water, using hand sanitiser if soap and water are not available, and covering mouth and nose with a tissue or sleeve when coughing or sneezing [4]. Then, on 3 March 2020, the UK Government published its action plan setting out the UK-wide response to the novel coronavirus. The UK Government's response outlined measures in four key areas: containing the outbreak, delaying its spread, mitigating the impact, and research to improve diagnostics and treatment [5].

On March 16 2020, five days after the WHO declared the outbreak of COVID-19 a pandemic, the UK Prime Minister announced a shift to the delay phase of the UK response with measures aimed at suppressing the spread of the infection in the population through non-pharmaceutical interventions (NPIs), including social distancing of the whole population, isolation of cases for 7 days and quarantine of their household members for 14 days [6]. The public was advised to stop non-essential contact with others and all unnecessary travel: including working from home where possible and avoiding pubs, theatres, restaurants and other social venues [6]. This shift in response was prompted by a mathematical modelling study which showed that a combination of social distancing of the entire population, home isolation of cases and household quarantine of their family members (and possible school and university closure) was required to suppress transmission to a level that would enable the NHS to cope with the surge in cases requiring hospital admission and ventilation [7].

The effect of NPIs to reduce transmission rates is dependent on compliance with public health advice on social distancing. In the initial stages of the UK epidemic, this advice was voluntary, and not enforced by the government. This was criticised due to concern that

measures may not have the desired impact if a significant proportion of the population were unable or unwilling to comply. As such, this study aimed to assess reported behaviour and intention to comply with the NPIs, as recommended by the UK Government at the time of the survey. Preliminary findings were shared with the Scientific Advisory Group for Emergencies (SAGE), which advises the UK Government's response to COVID-19 [8].

Methods

Study design and sample

A cross-sectional survey of a nationally representative sample of the UK adult (aged 18 years and over) population was conducted between March 17 and 18 2020, which followed the UK Government's 16 March announcement to increase social distancing measures by advising the public to stop non-essential contact with others and all unnecessary travel [6].

The online survey was administered by YouGov, a market research company, to members of its UK panel of 800,000+ individuals as part of their omnibus survey [9]. A sample of 2,108 adults was achieved through YouGov's non-probabilistic active sampling method [9]. Emails were sent to panellists from the base sample, randomly selecting panellists with particular characteristics to achieve quotas that matched the proportions of people with those characteristics in the UK 2011 census data [10]. The responding sample was weighted to be representative of the UK adult population.

Survey Instrument

The questionnaire was adapted from a survey used in a similar study conducted in Hong Kong [11]. The questionnaire had four components: (1) socio-demographic characteristics, (2) risk perceptions towards COVID-19, (3) preventive behaviours, and (4) willingness and ability to self-isolate.

Socio-demographic characteristics consisted of sex, age, ethnicity, marital status, caring responsibilities, UK area of residence, and socio-economic status (SES). SES was assessed using five indicators: education level, employment status, household income, savings, and household tenure.

Risk perceptions towards COVID-19 were measured by perceived susceptibility and perceived severity. Susceptibility was measured by asking respondents about perceived

likelihood of being infected with COVID-19 under the UK Government's current preventive measures. Severity was measured by asking respondents about perceived seriousness of symptoms if they were infected with COVID-19.

Preventive behaviours included information on perceived effectiveness and actual adoption of preventive behaviours (to protect oneself and others), to prevent both contracting COVID-19 and onward transmission, and were collected under three categories: (1) hygiene practices (wearing a face mask, washing hands more frequently with soap and water, using hand sanitiser more regularly, disinfecting the home, covering nose and mouth when sneezing or coughing) (2) travel avoidance (travel to affected countries and travel to areas inside and outside the UK, regardless of whether they were affected) (3) social distancing (avoiding public transport, social events, going out in general, going to hospital or other healthcare settings, crowded places, and contact with people who have a fever or respiratory symptoms).

Willingness and ability to self-isolate if asked by a healthcare professional were measured using two questions developed for this survey. At the time the survey was conducted, Public Health England's operational definition of 'self-isolation' was "*if you have symptoms of coronavirus infection (COVID-19), however mild, do not leave your home (even to buy food or essentials) or have any visitors for 7 days from when your symptoms started. This includes not going to work, school or other public places, and avoiding public transport or taxis. Self-isolation is the same as voluntary quarantine.*"[12]

We worked with YouGov to optimise question clarity and ease of understanding for the UK population.

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/covid-19-resources/

Data Collection

Data were collected between 1630 GMT on 17 March 2020 and 1030 GMT on 18 March 2020. Participants identified for the sample were sent an email with a survey link. YouGov returned the anonymised data set to the Imperial College London research team for analysis.

Data Analysis

Analyses were conducted in Stata 15 and SPSS version 25.

Descriptive statistics for all variables present the number of respondents and the weighted percentages.

Logistic regression was used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) willingness and (4) ability to self-isolate. Adoption of social distancing measures was proxied by respondents reporting to have avoided crowded places and social events to protect themselves or others from COVID-19.

Variables that appeared to be associated ($p<0{\cdot}20$) in the unadjusted analyses were considered in the adjusted analyses. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) were estimated. Associations with a p-value $<0{\cdot}05$ in the adjusted analyses were considered to be statistically significant.

We tested for collinearity between education level, employment status, household income, savings, and household tenure. For these categorical variables, collinearity was measured by examining bivariate relationships using Pearson's Chi-squared tests. Where collinearity was detected we ran separate adjusted regression analyses for those variables, using only other explanatory variables in those models that were not strongly correlated.

Patient and Public Involvement

We distributed an online feedback form to communities across the UK using local networks of public partners and contacts, Twitter and via VOICE-global.org, an online platform for public involvement in research established by Newcastle University. We received 420 responses, including 328 from members of the public. The experiences and feedback shared guided our study design and scope, including the phrasing of the survey tool's closed-ended questions and the refinement of pre-populated answer choices.

Study results will be shared with the public both by posting on the VOICE-global.org news page, on the research team's website, and through direct mail with those who consented to be contacted about our research and involvement activity.

Ethical approval

The Imperial College London Research Ethics Committee approved the study (Ref 20IC5861). Informed consent was obtained from those who chose to complete the survey after having read introductory information on its content and purpose.

Results

The overall sample was designed to be representative of the UK adult population and is described in Table 1. In summary, of the 2,108 respondents, 11·1% were 18 to 24 years old, and 13·5% were 70 years or older. The majority of respondents were white (93·9%). In total, 43·4% were in full-time work and 14·1% were in part-time work.

Overall, 77·4% (1,640/2,108) of respondents reported being worried about the COVID-19 outbreak in the UK. For those that had not previously tested positive for COVID-19, 47·5% (979/2,108) believed that it was likely they would be infected at some point in the future under the UK Government's preventive measures. If infected, just over half (56·9%) of respondents would expect to be moderately severely affected (e.g. may need self-care and rest in bed) (Table 1).

Accordingly, 94·2% of adults reported taking at least one preventive measure (to protect oneself and others) against COVID-19 infection: 85·8% washed their hands with soap more frequently; 56·5% avoided crowded areas; 54·5% avoided social events and 39·2% avoided public transport (Figure 1). Most reported that their behaviour change was in response to government guidance (71·3%). Preventive measures perceived to be most effective were washing hands more frequently with soap and water (92·5%), avoiding contact with people who have a fever or respiratory symptoms (91·4%), and covering nose and mouth when sneezing or coughing (90·0%) (Figure 1). Perceived effectiveness of preventive measures was higher than actual adoption for all measures. This was particularly marked for social distancing measures (Figure 1).

Adoption of social-distancing measures

Overall, 45·2% of respondents reported adopting social distancing measures (avoiding crowded places and avoiding social events) to protect themselves or others from COVID-19.

Table 2 shows the regression analysis results for adoption of social-distancing measures. Being 70 years or older (64·2% vs. 38·4%; aOR:1·9; 95% CI:1·1,3·4) was positively associated with greater adoption compared to younger adults aged 18 to 34 years. Compared with those who were married, in a civil partnership, or living as married (48·4%), respondents who were separated, divorced, or widowed (44·1%; aOR:0·63; 95% CI:0·43,0·91) or never married (38·4; aOR:0·70; 95% CI:0·50,0·97) were less likely to have adopted social distancing measures to prevent transmission of COVID-19.

Table 1. Demographics, socio-economic characteristics and COVID-19 risk perceptions, N=2,108

Characteristic	No.	Weighted %
Demographic and socio-economic		
Age (years)		
18-24	218	11·1
25-34	294	14·4
35-44	396	19·3
45-54	355	17·5
55-69	519	24·2
70 or above	326	13·5
Sex		
Male	987	48·0
Female	1094	50·7
Prefer not to say	27	1·3
Ethnicity		
White	1985	93·9
Asian/Asian British	48	2·4
Black / African / Caribbean / Black British	20	1·0
Other ethnic group, including mixed/multiple ethnic groups	39	1·9
Prefer not to say	16	0·77
Marital status		
Married, civil partnership, or living as married	1283	60·3
Separated, divorced, or widowed	270	12·2
Never married	545	27·1
Prefer not to say	10	0·45
Area of residence		
London	239	13·1
North	522	23·3
Midlands	531	25·2
South	485	22·5
N. Ireland, Scotland, Wales	331	15·9
Education		
No formal qualification	121	5·5
Secondary-level qualification	859	42·1
Post-secondary-level, below bachelor	148	6·9
Bachelor-level or above	664	30·8
Other technical, professional or higher qualification	245	11·2
Don't Know	32	1·6
Prefer not to say	39	2·0
Employment status		

Working full time	889	43·4
Working part time	292	14·1
Full time student	112	5·6
Retired	553	23·6
Unemployed or not working	207	10·5
Other	55	2·8
Household income		
<£20,000	440	20·7
£20,000 to £29,999	355	16·8
£30,000-£49,999	472	22·4
£50,000 and over	429	20·6
Don't know	103	5·1
Prefer not to say	309	14·4
Savings		
Less than £100	278	13·6
£100 to £999	242	11·8
£1,000 to £4,999	305	14·5
£5,000 to £24,999	359	16·6
£25,000 or more	359	16·6
Prefer not to say	565	26·9
Housing tenure		
Own – outright	681	30·4
Own – mortgage/shared ownership	639	30·8
Rent – private landlord	319	15·6
Rent – local authority/housing association	219	10·7
Live with parents, family or friends	215	10·7
Other	35	1·8
COVID-19 risk perceptions		
Level of worry about the current COVID-19 outbreak in the UK		
Worried	1640	77·4
Not worried	454	21·9
Don't know	14	0·74
Perceived susceptibility[a]		
Likely	979	47·5
Neither likely or unlikely	547	26·2
Unlikely	337	15·9
Don't know	220	10·5
Perceived severity[b]		
I would expect it to be life-threatening	103	4·7
I would expect it to be severe (e.g. may need care and treatment in hospital)	306	14·2
I would expect it to be moderate (e.g. may need self-care and rest in bed)	1180	56·9
I would expect it to be mild (e.g. can go about daily tasks normally)	351	17·2
I would expect to have no symptoms	33	1·7
Don't know	110	5·3

[a]Under the UK government's current preventive measures (at the time of the study), how likely or unlikely do you think it is you will be infected with the coronavirus (COVID-19) at any point in the future?

[b]Please imagine you were infected with coronavirus (i.e. COVID-19), which of the following do you think would best apply?

Figure 1. Perceived effectiveness and actual adoption of preventative measures to prevent transmission of COVID-19; N=2,108

Table 2. Social distancing behaviour and ability to work from home by a range of sociodemographic factors, N=2,108

	Social distancing measures being taken yes vs no [a]				Able to work from home yes vs no (N=1,149) [d]			
	N	Weighted %	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	N	Weighted %	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Social distancing								
Yes	969	45·2						
No	1,139	54·8						
Ability to work from home								
Yes					540	44·3		
No					609	53·0		
Don't Know					32	2·7		
Age								
18-34	202	38·4	Ref	Ref[b]	154	48·0	Ref	Ref[e]
35-49	229	40·8	1·1 (0·86-1·4)	1·2 (0·83-1·7)	220	48·0	1·0 (0·75-1·3)	0·95 (0·63-1·4)
50-69	329	46·4	**1·4 (1·1-1·8)****	1·2 (0·85-1·8)	151	39·9	**0·72 (0·53-0·98)***	0·68 (0·43-1·1)
70 or older	209	64·2	**2·9 (2·2-3·8)*****	**1·9 (1·1-3·4)***	15	53·9	1·3 (0·57-2·8)	2·0 (0·57-7·0)
Sex								
Male	436)	42·9	Ref	Ref[b]	280	46·1	Ref	-
Female	519	47·4	**1·2 (1·0-1·4)***	1·1 (0·90-1·4)	254	44·8	0·95 (0·75-1·2)	
Ethnicity								
White	919	45·5	Ref	-	506	45·1	Ref	Ref[e]
Black, Asian and minority ethnic	45	42·1	0·87 (0·58-1·3)		31	54·2	1·4 (0·84-2·5)	1·2 (0·56-2·4)
Marital status								
Married, civil partnership, or living as married	628	48·4	Ref	Ref[b]	366	47·2	Ref	-
Separated, divorced, or widowed	121	44·1	0·84 (0·64-1·1)	**0·63 (0·43-0·91)***	43	39·5	0·73 (0·48-1·1)	
Never married	214	38·4	**0·66 (0·54-0·82)*****	**0·70 (0·50-0·97)***	128	43·5	0·86 (0·66-1·1)	
Area of residence								
London	111	45·2	Ref	-	76	54·0	Ref	Ref[e]
North of England	220	41·6	0·86 (0·63-1·2)		129	44·7	0·69 (0·45-1·0)	1·1 (0·63-1·8)
Midlands and East of England	249	46·0	1·0 (0·76-1·4)		123	44·4	0·68 (0·45-1·0)	0·93 (0·54-1·6)
South of England	221	45·0	0·99 (0·72-1·4)		151	49·0	0·82 (0·54-1·2)	1·1 (0·66-1·8)

N. Ireland, Scotland, Wales	168	49·9	1·2 (0·86-1·7)		61	35·2	**0·46 (0·29-0·74)*** **	0·57 (0·31-1·0)
Education								
Degree or above	321	48·0	Ref	-	289	62·6	Ref	Ref[f]
Post-secondary	186	46·7	0·95 (0·74-1·2)		105	47·7	**0·54 (0·39-0·76)*** **	**0·58 (0·41-0·82)** **
Secondary or below	436	43·7	0·84 (0·69-1·0)		137	29·4	**0·25 (0·19-0·33)*** **	**0·29 (0·21-0·39)*** **
Employment status								
Working full time	344	38·6	Ref	Ref[b]	439	48·9	Ref	Ref[e]
Working part time	136	46·8	**1·4 (1·1-1·8)** **	1·2 (0·85-1·7)	101	35·0	**0·56 (0·42-0·74)*** **	0·74 (0·50-1·1)
Full time student	43	36·3	0·91 (0·60-1·4)	1·4 (0·71-2·6)	N/A	N/A	N/A	N/A
Retired	331	59·7	**2·4 (1·9-2·9)*** **	1·5 (0·99-2·3)	N/A	N/A	N/A	N/A
Unemployed / Not working	95	45·4	1·3 (0·97-1·8)	1·4 (0·90-2·2)	N/A	N/A	N/A	N/A
Household income								
£50,000 and over	178	41·0	Ref	Ref[c]	241	67·3	Ref	Ref[g]
£30,000 to £49,999	211	43·8	1·1 (0·86-1·5)	1·0 (0·77-1·4)	131	42·6	**0·36 (0·26-0·50)*** **	**0·36 (0·26-0·51)*** **
£20,000 to £29,999	173	48·5	**1·4 (1·0-1·8)***	1·2 (0·87-1·6)	64	30·7	**0·22 (0·15-0·31)*** **	**0·22 (0·15-0·32)*** **
<£20,000	218	49·0	**1·4 (1·1-1·8)***	1·1 (0·79-1·5)	31	22·7	**0·14 (0·09-0·23)*** **	**0·16 (0·09-0·26)*** **
Savings								
£25,000 or more	177	48·4	Ref	Ref[c]	100	59·9	Ref	Ref[g]
£5,000 to £24,999	177	48·7	1·0 (0·75-1·4)	1·3 (0·94-1·8)	131	57·6	0·91 (0·60-1·4)	0·77 (0·49-1·2)
£1,000 to £4,999	126	40·7	0·73 (0·54-1·0)	1·0 (0·72-1·4)	89	43·7	**0·52 (0·34-0·80)** **	**0·46 (0·29-0·72)** **
£100 to £999	91	37·4	**0·64 (0·45-0·89)** **	0·89 (0·61-1·3)	67	40·1	**0·45 (0·29-0·70)*** **	**0·41 (0·26-0·67)*** **
Less than £100	122	43·5	0·82 (0·60-1·1)	1·1 (0·79-1·6)	54	33·1	**0·33 (0·21-0·52)*** **	**0·30 (0·18-0·49)*** **
Housing tenure								
Own outright	377	55·0	Ref	Ref[c]	93	41·0	Ref	Ref[g]
Own with mortgage/shared ownership	261	40·8	**0·56 (0·45-0·70)*** **	0·87 (0·66-1·1)	293	55·0	**1·8 (1·3- 2·4)***	1·4 (0·96-2·1)
Rented from private landlord	145	45·0	**0·67 (0·51-0·88)** **	1·1 (0·79-1·5)	85	39·8	0·95 (0·65-1·4)	0·65 (0·40-1·0)
Rented from local authority/housing association	94	42·2	**0·60 (0·44-0·82)** **	0·79 (0·56-1·1)	16	18·2	**0·32 (0·17-0·59)*** **	**0·37 (0·18-0·75)** **
Live with parents, family, or friends	78	35·4	**0·45 (0·32-0·62)*** **	0·84 (0·54-1·3)	46	43·6	1·1 (0·69-1·8)	0·96 (0·54-1·7)

[a]Those that report avoiding crowded areas AND social events; [b]Mutually adjusted for age, sex, marital status, employment status, household income, savings and housing tenure; [c]Adjusted for age, sex, marital status and employment status. [d]Excluding those who responded "Don't know"; [e]Mutually adjusted for age, ethnicity, UK area of residence, household income, savings and housing tenure; [f]Adjusted for age, ethnicity, UK area of residence and housing tenure; [g]Adjusted for age, ethnicity and UK area of residence. *p<·05, **p<·01, ***p<·001

Ability to work from home

Overall, 44·3% of respondents reported being able to work from home (i.e. permitted by their employer and have the necessary equipment to do their job from home).

Respondents who held post-secondary but below degree-level (47·7%; aOR:0·58; 95% CI:0·41,0·82) and secondary or below level (29·4%; aOR:0·29; 95% CI:0·21,0·39) education qualifications were less likely to be able to work from home compared with those educated to degree level (62·6%) (Table 2). As with educational level, there was a household income and savings gradient with ability to work from home. Those with the lowest household income (<£20,000) were six times less likely to be able to work from home compared to those with household incomes of £50,000 and above (22·7% vs. 67·3%; aOR:0·16; 95% CI:0·09,0·26). Respondents with £100 savings or less were three times less likely to be able to work from home compared to those with £25,000 or more in savings (33·1% vs. 59·9%; aOR:0·33; 95% CI:0·21,0·52) (Table 2).

Compared with those who owned their home outright, those renting accommodation from a local authority or housing association were less likely to be able to work from home (18·2% vs. 41·0%; aOR:0·37; 95% CI:0·18,0·75).

Willingness and ability to self-isolate

Overall, perceived ability (87·0%) and willingness (87·6%) to self-isolate for 7 days if asked by a healthcare professional were high.

In terms of socio-demographic associations, there was no effect of sex on perceived ability to self-isolate (Table 3). However, women were somewhat more willing to do so than men (94·9% vs. 91·8%; aOR:2·1; 95% CI:1·2,3·5). Respondents from ethnic minority backgrounds perceived themselves to be less able to self-isolate than respondents from White backgrounds (84·8% vs. 92·1%, aOR:0·47; 95% CI:0·27,0·82), although they were equally willing to do so (Table 3).

Some indicators of socioeconomic status were significantly associated with perceived ability and willingness to self-isolate. Respondents who held post-secondary but below degree-level education qualifications were less able (90·2% vs. 93·1%; aOR:0·59; 95% CI:0·36,0·97) and less willing (90·9% vs. 94·9% aOR:0·50; 95% CI:0·29,0·85) to self-isolate than respondents educated to degree level (Table 3). Those with household incomes below

Table 3. Ability and willingness to self-isolate by sociodemographic factors

	Able to self-isolate yes vs no (N=2,002)[a]				Willing to self-isolate yes vs no (N=1,978) [a]			
	N	Weighted %	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	N	Weighted %	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Self-isolation ability/willingness								
Yes, I would	1,834	87·0			1,847	87·6		
No, I wouldn't	168	8·0			131	6·2		
Don't know	106	5·0			130	6·2		
Age								
18-34	466	90·8	Ref	Ref[b]	457	91·6	Ref	Ref[b]
35-49	494	90·0	0·91 (0·60-1·4)	1·3 (0·70-2·3)	508	94·2	1·5 (0·95-2·5)	1·3 (0·65-2·7)
50-69	614	92·2	1·2 (0·79-1·8)	1·5 (0·74-3·1)	627	93·6	1·4 (0·87-2·1)	1·0 (0·46-2·3)
70 or older	262	94·9	**1·9 (1·0-3·6)***	1·8 (0·52-6·4)	255	94·4	1·6 (0·87-2·9)	1·5 (0·44-5·0)
Sex								
Male	878	90·7	Ref	Ref[b]	878	91·8	Ref	Ref[b]
Female	957	92·5	1·3 (0·92-1·7)	1·2 (0·78-1·9)	969	94·9	**1·7 (1·2-2·4)****	**2·1 (1·2-3·5)****
Ethnicity								
White	1,737	92·1	Ref	Ref[b]	1,751	93·7	Ref	Ref[b]
Black, Asian and minority ethnic	89	84·8	**0·47 (0·27-0·82)****	**0·33 (0·15-0·72)****	86	87·8	**0·48 (0·26-0·9)***	0·70 (0·28-1·8)
Marital status								
Married, civil partnership, or living as married	1,128	92·3	Ref	Ref[b]	1,143	94·5	Ref	Ref[b]
Separated, divorced, or widowed	215	90·7	0·80 (0·49-1·3)	0·94 (0·44-2·0)	219	92·8	0·77 (0·44-1·4)	0·74 (0·33-1·7)
Never married	482	90·3	0·77 (0·54-1·1)	1·1 (0·60-1·9)	477	91·0	**0·59 (0·40-0·87)****	0·88 (0·45-1·7)
Area of residence								
London	241	91·6	Ref	-	243	92·7	Ref	-
North of England	427	91·2	0·93 (0·54-1·6)		430	93·7	1·2 (0·64-2·1)	
Midlands and East of England	465	93·0	1·2 (0·69-2·1)		465	93·9	1·2 (0·67-2·2)	
South of England	408	89·5	0·76 (0·45-1·3)		411	92·2	0·92 (0·51-1·6)	
N. Ireland, Scotland, Wales	294	92·7	1·2 (0·63-2·1)		297	94·3	1·3 (0·66-2·5)	
Education								
Degree or above	584	93·1	Ref	Ref[c]	591	94·9	Ref	Ref[c]

Post-secondary	332	90·2	0·68 (0·43-1·1)	**0·59 (0·36-0·97)***	329	90·9	**0·53 (0·32-0·88)***	**0·50 (0·29-0·85)***
Secondary or below	863	91·3	0·78 (0·53-1·2)	0·71 (0·47-1·1)	873	93·6	0·77 (0·50-1·21)	0·99 (0·61-1·9)
Employment status								
Working full time	799	91·4	Ref	Ref[b]	804	93·6	Ref	Ref[b]
Working part time	255	90·4	0·88 (0·55-1·4)	0·85 (0·45-1·6)	263	92·9	0·90 (0·53-1·5)	0·58 (0·29-1·2)
Full time student	105	93·8	1·37 (0·62-3·0)	1·6 (0·50-5·4)	97	89·0	0·55 (0·29-1·1)	0·49 (0·17-1·4)
Retired	450	95·1	**1·8 (1·1-3·0)***	1·2 (0·48-3·1)	444	94·7	1·2 (0·74- 2·0)	0·78 (0·33-1·9)
Unemployed or not working	185	89·8	0·81 (0·49-1·3)	1·1 (0·49-2·3)	191	94·1	1·1 (0·56-2·0)	2·4 (0·75-7·5)
Household income								
£50,000 and over	405	95·5	Ref	Ref[d]	393	94·7	Ref	Ref[d]
£30,000 to £49,999	417	90·7	**0·46 (0·27-0·81)****	**0·44 (0·25-0·77)****	424	93·6	0·81 (0·46-1·4)	0·73 (0·40-1·3)
£20,000 to £29,999	311	92·6	0·60 (0·33-1·1)	0·54 (0·28-1·0)	308	91·9	0·63 (0·35-1·1)	0·57 (0·30-1·1)
<£20,000	363	88·3	**0·36 (0·21-0·62)*****	**0·31 (0·16-0·58)*****	383	93·0	0·73 (0·41-1·3)	0·71 (0·36-1·4)
Savings								
£25,000 or more	329	95·6	Ref	Ref[d]	318	94·1	Ref	Ref[d]
£5,000 to £24,999	319	95·2	0·93 (0·45-1·9)	1·2 (0·56-2·6)	317	95·8	1·5 (0·72-2·9)	1·5 (0·70-3·1)
£1,000 to £4,999	274	92·3	0·55 (0·28-1·1)	0·73 (0·36-1·5)	272	92·8	0·82 (0·44-1·6)	0·83 (0·42-1·6)
£100 to £999	217	90·0	**0·42 (0·22-0·81)***	0·60 (0·29-1·3)	221	94·8	1·2 (0·56-2·5)	1·2 (0·53-2·6)
Less than £100	232	84·4	**0·25 (0·13-0·45)*****	**0·35 (0·18-0·68)****	250	90·9	0·63 (0·34-1·2)	0·55 (0·28-1·1)
Housing tenure		93·8						
Own outright	576	92·1	Ref	Ref[d]	575	95·0	Ref	Ref[d]
Own with mortgage/shared ownership	571	89·1	0·77 (0·50-1·2)	0·99 (0·58-1·7)	584	95·0	0·98 (0·59-1·6)	0·87 (0·47-1·6)
Rented from private landlord	277		**0·53 (0·33-0·86)***	0·71 (0·39-1·3)	297	94·3	0·85 (0·47-1·6)	0·82 (0·40-1·7)
Rented from local authority/housing		87·9						
association	188	92·9	**0·49 (0·29-0·82)****	0·68 (0·36-1·3)	188	90·0	**0·47 (0·26-0·84)***	**0·39 (0·21-0·75)****
Live with parents, family, or friends	197		0·85 (0·46-1·6)	1·3 (0·60-3·0)	178	88·1	**0·39 (0·22-0·69)****	**0·43 (0·20-0·95)***

[a]Excluding those who responded "Don't know"; [b]Mutually adjusted for age, gender, ethnicity, marital status, education, employment status, household income, savings, and housing tenure; [c]Adjusted for age gender, ethnicity, marital status, employment status and housing tenure; [d]Adjusted for age, gender, ethnicity, marital status, and employment status; *p<·05, **p<·01, ***p<·001

£20,000 were three times less likely to be able to self-isolate compared with those on household incomes of £50,000 and above (88·3% vs. 95·5%; aOR:0·31; 95% CI:0·16,0·58). Similarly, respondents with less than £100 in savings were three times less likely to be able to self-isolate compared with those with savings of £25,000 or more (84·8% vs. 95·6%; aOR:0·35; 95% CI:0·18,0·68). There was no effect on willingness to self-isolate by household income or amount of savings (Table 3).

Those in accommodation rented from a private landlord, local authority, or housing association were less likely to report being able to self-isolate, although this association was no longer significant when other sociodemographic factors were adjusted for. In terms of willingness to self-isolate, respondents renting accommodation from a local authority or housing association (aOR:0·39; 95% CI:0·21,0·75) and those living with parents, family or friends (aOR:0·43; 95% CI:0·20,0·95) were less likely to be willing to self-isolate compared with those who owned their home outright (Table 3).

Discussion

This study reports on the perceptions and behaviour of the UK adult population in the two days following the UK Government's introduction of recommendations on social distancing on March 16 2020 [6]. We found high levels of self-reported behaviour change. Notably, the most-adopted measures, washing hands more frequently with soap and water, using hand sanitiser, and covering nose and mouth when sneezing or coughing, prominently featured in national public health campaigns from relatively early on in the epidemic [4], and mirrors results seen in previous pandemics [13]. However, there were marked differences between the perceived effectiveness and adoption of NPIs. This suggests that lack of knowledge on what measures are effective against COVID-19 is not a key driver of compliance in the UK population. In contrast, a similar study conducted in Hong Kong showed comparatively high perceived effectiveness and adoption of preventive measures [11].

Our results highlighted significant differences across demographic and socioeconomic strata for social distancing behaviour, ability to work from home, and the ability and willingness of people to self-isolate. Adoption of social distancing measures was almost twice as likely in people over 70 compared to adults aged 18 to 34 years. Notably, those that were single were less likely to practice social distancing. There was a strong association between socioeconomic deprivation and ability to adopt NPIs. Although willingness to self-isolate

was high overall, those from more disadvantaged backgrounds were less likely to be able to work from home or self-isolate if needed, suggesting the existence of structural barriers to adopting preventive behaviours in these groups.

The strength of this study is in the representative sample of the UK adult population, the ability to achieve our sample size quickly, and the timeliness in relation to changing government recommendations. This study has three limitations. First, with an online approach, responses of those without internet access were under-represented. Second, the survey tool consisted of predominantly closed-ended questions. Thus, we were unable to explore responses in more depth. Third, surveys collecting self-report data are generally subject to limitations including honesty, introspective ability, and interpretation of the questions.

Our findings highlight the stark choices faced by those in lower socioeconomic groups and suggest that unless the government intervenes to support these individuals, the impact of this epidemic will likely be felt unequally in our society. Not only this, but if a large proportion of the population continues to work while unwell, low compliance will render the various forms of social distancing less effective, as low-income workers are forced to choose between financial and physical health. Indeed, this behaviour has already been observed in the workplace in previous pandemics: workers without access to paid sick leave were more likely to work while unwell than those with paid sick leave [14]. A study in China after the H7N9 epidemic found that only 7% of people reported willingness to self-quarantine [15]. Also, during the Middle East Respiratory Syndrome (MERS) outbreak in South Korea in 2015, there was heterogeneous uptake of preventive interventions [16].

In the absence of a vaccine and treatments over the short-term, high compliance with social distancing, self-isolation and household quarantine is paramount to reduce transmission and the impact of COVID-19. And as the epidemic evolves, it is likely that compliance with preventive behaviours will continue to evolve too. NPI compliance, risk perception and behaviour are not consistent across cultures, social status or time. Indeed, previous studies have shown that perceptions and behaviours often change over time [13]. Therefore, current modelling projections of the impact of NPIs on morbidity and mortality are always provisional [7]. Future COVID-19 models should explore the variation captured in this and previous studies to better estimate the impact of differential uptake of NPIs in the UK and

beyond. It is also important to monitor behaviour throughout the epidemic to know when to implement further public health messaging, and when further or alternative government actions might be required, to mitigate falling compliance.

Conclusions and policy implications

Our findings highlight that those most economically disadvantaged in society are less able to comply with certain NPIs, likely in part due to their financial situation. Whilst one approach may be to better tailor public health messaging to this subpopulation, this must be done alongside considered fiscal and monetary policy to mitigate the financial costs of following government public health advice. Therefore, it is imperative that the UK Government, and governments around the world, quickly develop and implement policies to support the most vulnerable, in a bid to minimise the long-term social and economic harm caused by COVID-19. Government policy should recognise the disparity in impact across socioeconomic groups, particularly across the labour market, and should aim to support workers equitably across the income spectrum. This would likely help increase compliance across the population to the levels required to suppress transmission and thereby reduce the strain on national health services, both in the UK and abroad. Although the UK Government has since announced a range of measures to support public services, individuals, and businesses, in part to facilitate compliance with current lockdown measures [17], it is uncertain how long these protections will be in place for and whether they will continue once lockdown restrictions are lifted.

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Contributors

CJA, LB, RR, PP and HW designed the study. CJA, JWE and CV analysed the data and performed the statistical analyses. CJA, LB, RR, CV and HW drafted the initial manuscript. All authors reviewed the drafted manuscript for critical content and approved the final version. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. CJA and HW are the guarantors.

Declaration of interests

The authors declare that they have no know competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data sharing

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/news--wuhan-coronavirus/covid-19-resources/

The data used for the analyses are available from the corresponding author on request.

References

1. World Health Organisation. Rolling updates on coronavirus disease (COVID-19) 2020 [Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.
2. ECDC. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – seventh update Stockholm; 2020 25 March 2020
3. Public Health England. Number of coronavirus (COVID-19) cases and risk in the UK 2020 [Available from: https://www.gov.uk/guidance/coronavirus-covid-19-information-for-the-public.
4. Russell P. New Coronavirus: UK Public Health Campaign Launched. Medscape. 2020.
5. Department of Health and Social Care. Coronavirus (COVID-19) action plan 2020 [Available from: https://www.gov.uk/government/publications/coronavirus-action-plan.

6. UK Government. PM statement on coronavirus: 16 March 2020 2020 [Available from: https://www.gov.uk/government/speeches/pm-statement-on-coronavirus-16-march-2020.

7. Ferguson NM, Laydon D, Nedjati-Gilani G, et al. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand. 2020.

8. Atchison CJ, Bowman L, Eaton JW, et al. Report 10: Public Response to UK Government Recommendations on COVID-19: Population Survey, 17-18 March 2020 2020.

9. YouGov. ESOMAR28: 28 questions to help online research buyers14 March 2020. Available from: http://doc.ukdataservice.ac.uk/doc/7647/mrdoc/pdf/7647_methodology_esomar_28.pdf.

10. Office for National_Statistics. UK 2011 census data [Available from: https://www.ons.gov.uk/census/2011census.

11. Kwok KO, Li KK, Chan HHH, et al. Community responses during the early phase of the COVID-19 epidemic in Hong Kong: risk perception, information exposure and preventive measures. medRxiv. 2020.

12. Public Health England. Stay at home: guidance for households with possible coronavirus (COVID-19) infection 2020 [Available from: https://www.gov.uk/government/publications/covid-19-stay-at-home-guidance/stay-at-home-guidance-for-households-with-possible-coronavirus-covid-19-infection.

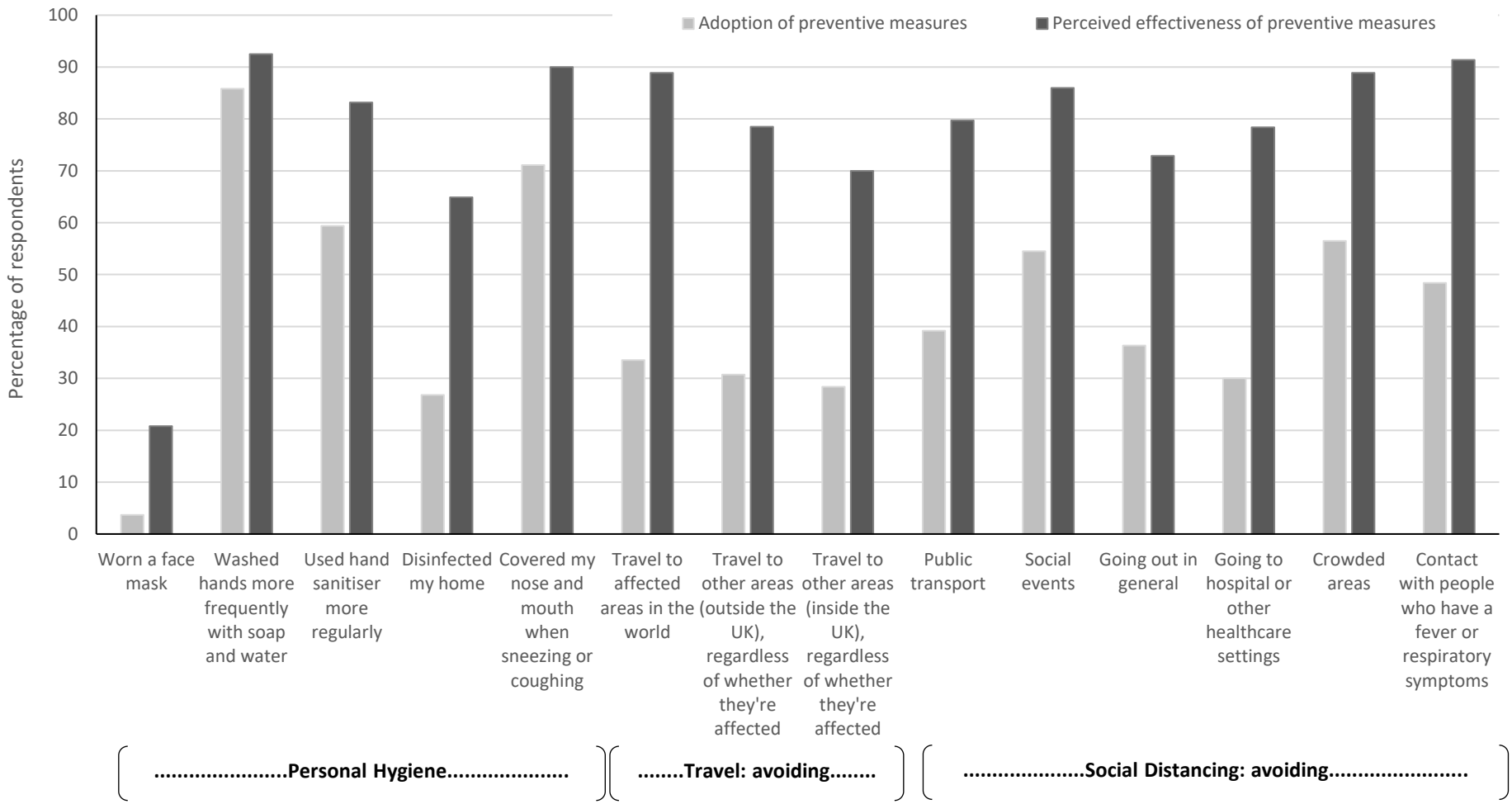
13. Bults M, Beaujean DJ, Richardus JH, Voeten HA. Perceptions and behavioral responses of the general public during the 2009 influenza A (H1N1) pandemic: a systematic review. Disaster Med Public Health Prep. 2015;9(2):207-19. doi: 10.1017/dmp.2014.160.

14. Ahmed F, Zviedrite N, Uzicanin A. Effectiveness of workplace social distancing measures in reducing influenza transmission: a systematic review. BMC Public Health. 2018;18(1):518. doi: 10.1186/s12889-018-5446-1.

15. Goodwin R, Sun S. Public perceptions and reactions to H7N9 in Mainland China. J Infect. 2013;67(5):458-62. doi: 10.1016/j.jinf.2013.06.014. Epub Jul 5.

16. Jang WM, Cho S, Jang DH, et al. Preventive Behavioral Responses to the 2015 Middle East Respiratory Syndrome Coronavirus Outbreak in Korea. Int J Environ Res Public Health. 2019;16(12).(pii):ijerph16122161. doi: 10.3390/ijerph.

17. UK Government. Support for those affected by Covid-19 2020 [Available from: https://www.gov.uk/government/publications/support-for-those-affected-by-covid-19.


Adoption of preventive measures
Perceived effectiveness of preventive measures
Percentage of respondents
100
90
80
70
60
50
40
30
20
10
0
Worn a face mask
Washed hands more frequently with soap and water
Used hand sanitiser more regularly
Disinfected my home
Covered my nose and mouth when sneezing or coughing
Travel to affected areas in the world
Travel to other areas (outside the UK), regardless of whether they're affected
Travel to other areas (inside the UK), regardless of whether they're affected
Public transport
Social events
Going out in general
Going to hospital or other healthcare settings
Crowded areas
Contact with people who have a fever or respiratory symptoms
.....Personal Hygiene.....
.....Travel: avoiding.....
.....Social Distancing: avoiding.....

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **PAGE 1 and 2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **PAGE 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **PAGE 4**
Objectives	3	State specific objectives, including any prespecified hypotheses **PAGE 4**
Methods		
Study design	4	Present key elements of study design early in the paper **PAGE 5-6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **PAGE 5-6**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **PAGE 5-6**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **PAGE 5-7**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **PAGE 5-6**
Bias	9	Describe any efforts to address potential sources of bias **PAGE 5 and 7**
Study size	10	Explain how the study size was arrived at **PAGE 5**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **PAGE 7**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **PAGE 7**
		(*b*) Describe any methods used to examine subgroups and interactions **PAGE 7**
		(*c*) Explain how missing data were addressed **N/A**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **PAGE 7**
		(*e*) Describe any sensitivity analyses **N/A**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **PAGE 8**
		(b) Give reasons for non-participation at each stage **N/A**
		(c) Consider use of a flow diagram **N/A**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **PAGE 8-15**
		(b) Indicate number of participants with missing data for each variable of interest **Tables 1-3**
Outcome data	15*	Report numbers of outcome events or summary measures **PAGE 8-15**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **PAGE 11-15; Tables 2-3**

		(*b*) Report category boundaries when continuous variables were categorized **PAGE 8-15; Tables 1-3**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **N/A**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **PAGE 10-15; Tables 2-3**
Discussion		
Key results	18	Summarise key results with reference to study objectives **PAGE 16**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **PAGE 17**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **PAGE 16-18**
Generalisability	21	Discuss the generalisability (external validity) of the study results **PAGE 17-18**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **PAGE 19**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Early perceptions and behavioural responses during the COVID-19 pandemic: A cross-sectional survey of UK Adults

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Keywords:	COVID-19, EPIDEMIOLOGY, Public health < INFECTIOUS DISEASES, INFECTIOUS DISEASES

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Early perceptions and behavioural responses during the COVID-19 pandemic: A cross-sectional survey of UK Adults

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Keywords: COVID-19, novel coronavirus, epidemic, behavioural response, risk perceptions

ABSTRACT

Objective: To examine risk perceptions and behavioural responses of the UK adult population during the early phase of the COVID-19 epidemic in the UK.

Design: A cross-sectional survey

Setting: Conducted with a nationally representative sample of UK adults within 48 hours of the UK Government advising the public to stop non-essential contact with others and all unnecessary travel.

Participants: 2,108 adults living in the UK aged 18 years and over. Response rate was 84.3% (2,108/2,500). Data collected between March 17 and 18 2020.

Main outcome measures: Descriptive statistics for all survey questions, including number of respondents and weighted percentages. Robust Poisson regression used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) ability and (4) willingness to self-isolate.

Results Overall, 1,992 (94.2%) respondents reported at least one preventive measure: 85.8% washed their hands with soap more frequently; 56.5% avoided crowded areas and 54.5% avoided social events. Adoption of social-distancing measures was higher in those aged over 70 compared to younger adults aged 18 to 34 years (aRR:1·2; 95% CI:1.1,1·5). Those with lowest household income were three times less likely to be able to work from home (aRR:0.33; 95% CI:0.24 to 0.45) and less likely to be able to self-isolate (aRR:0.92; 95% CI:0.88 to 0.96). Ability to self-isolate was also lower in black and minority ethnic groups (aRR:0.89; 95% CI:0.79 to 1.0). Willingness to self-isolate was high across all respondents.

Conclusions Ability to adopt and comply with certain non-pharmaceutical interventions (NPIs) is lower in the most economically disadvantaged in society. Governments must implement appropriate social and economic policies to mitigate this. By incorporating these differences in NPIs among socio-economic subpopulations into mathematical models of COVID-19 transmission dynamics, our modelling of epidemic outcomes and response to COVID-19 can be improved.

Keywords: COVID-19, novel coronavirus, epidemic, pandemic, behavioural response, risk perceptions

Article Summary

Strengths and limitations of this study

- Nationally representative sample of the UK adult population
- Quick data collection during a rapidly evolving public health emergency
- Timeliness in relation to changing government response and recommendations
- The online approach excludes those without internet access
- Collecting self-report data are generally subject to limitations including honesty, introspective ability and interpretation of the questions.

Introduction

On 31 December 2019, Chinese authorities notified the World Health Organisation (WHO) of an outbreak of pneumonia in Wuhan City, which was later classified as a new disease: COVID-19 [1]. Following identification of cases in countries outside China, on 30 January 2020, WHO declared the outbreak of COVID-19 a "Public Health Emergency of International Concern"[1]. In the UK, the first cases of COVID-19 were diagnosed at the end of January 2020, and community transmission was reported a few weeks later [2,3]. Government measures to control the epidemic were first announced on 22 January 2020 and included travel advice, information for those returning from affected countries, testing of suspected cases, isolation and contact tracing. This was followed in early February by a public health information campaign advising people to adopt hygiene measures to protect themselves and others, including more frequent handwashing with soap and water, using hand sanitiser if soap and water are not available, and covering mouth and nose with a tissue or sleeve when coughing or sneezing [4]. Then, on 3 March 2020, the UK Government published its action plan setting out the UK-wide response to the novel coronavirus. The UK Government's response outlined measures in four key areas: containing the outbreak, delaying its spread, mitigating the impact, and research to improve diagnostics and treatment [5].

On March 16 2020, five days after the WHO declared the outbreak of COVID-19 a pandemic, the UK Prime Minister announced a shift to the delay phase of the UK response with measures aimed at suppressing the spread of the infection in the population through non-pharmaceutical interventions (NPIs), including social distancing of the whole population, isolation of cases for 7 days and quarantine of their household members for 14 days [6]. The public was advised to stop non-essential contact with others and all unnecessary travel: including working from home where possible and avoiding pubs, theatres, restaurants and other social venues [6]. This shift in response was prompted by a mathematical modelling study which showed that a combination of social distancing of the entire population, home isolation of cases and household quarantine of their family members (and possible school and university closure) was required to suppress transmission to a level that would enable the NHS to cope with the surge in cases requiring hospital admission and ventilation [7].

The effect of NPIs to reduce transmission rates is dependent on compliance with public health advice on social distancing. In the initial stages of the UK epidemic, this advice was voluntary, and not enforced by the government. This was criticised due to concern that

measures may not have the desired impact if a significant proportion of the population were unable or unwilling to comply.

Protective behaviours are not uniformly adopted throughout a population during an epidemic. Evidence from influenza outbreaks suggests that females are more likely to adopt NPIs than males [8,9]. In the UK, during the H1N1 pandemic, non-white ethnic groups were more likely to adopt hygiene and social distancing behaviours compared to white [10,11]. Employment status has also been associated with NPI adoption [12,13]. Evidence from Australia during the H1N1 pandemic found those who were self-employed and who were unable to work from home were most likely to report intentions to not comply with preventative measures [13], suggesting that without support, it may be challenging for individuals who are unable to work from home to comply with certain public health recommendations. During the current COVID-19 pandemic, public risk perceptions and knowledge has been explored in various countries [14-20]**.** However, only few have identified the factors associated with greater adoption of preventative measures, or how these associations vary by context. In Hong Kong, both greater understanding of COVID-19 and increased anxiety were associated with greater adoption of social distancing behaviours [18].

As such, this study aimed to assess reported behaviour and intention to comply with the NPIs, as recommended by the UK Government at the time of the survey. Preliminary findings were shared with the Scientific Advisory Group for Emergencies (SAGE), which advises the UK Government's response to COVID-19 [21].

Methods

Study design and sample

A cross-sectional survey of a nationally representative sample of the UK adult (aged 18 years and over) population was conducted between March 17 and 18 2020, which followed the UK Government's 16 March announcement to increase social distancing measures by advising the public to stop non-essential contact with others and all unnecessary travel [6].

The online survey was administered by YouGov, a market research company, to members of its UK panel of 800,000+ individuals [22]. This panel includes individuals who have specifically opted in to participate in online research activities. YouGov actively recruits hard-

to-reach individuals to this panel (such as younger people and those from ethnic minorities) via a network of partners with specific experience in recruiting these audiences for online activities or with access to a wide range of online sources that cater to these groups.

A sample of 2,108 adults was achieved through non-probabilistic quota sampling [22]. Emails were sent to 2,500 panellists from the base sample, randomly selecting panellists with particular age, sex, ethnicity and UK geographical region of residence characteristics to achieve quotas that matched the proportions of people with those characteristics in the UK 2011 census data [23]. The response rate was 84.3% (2,108/2,500). No incentive was given to participate in the survey. The responding sample was weighted by age, sex, region and ethnicity to be representative of the UK adult population.

Survey Instrument

The questionnaire was adapted from a survey used in a similar study conducted in Hong Kong [24]. The questionnaire had four components: (1) socio-demographic characteristics, (2) risk perceptions towards COVID-19, (3) preventive behaviours, and (4) ability and willingness to self-isolate.

Socio-demographic characteristics consisted of sex, age, ethnicity, marital status, caring responsibilities, UK area of residence, and socio-economic status (SES). SES was assessed using five indicators: education level, employment status, household income, savings, and household tenure.

Risk perceptions towards COVID-19 were measured by perceived susceptibility and perceived severity. Susceptibility was measured by asking respondents about perceived likelihood of being infected with COVID-19 under the UK Government's current preventive measures. Severity was measured by asking respondents about perceived seriousness of symptoms if they were infected with COVID-19.

Preventive behaviours included information on perceived effectiveness and actual adoption of preventive behaviours (to protect oneself and others), to prevent both contracting COVID-19 and onward transmission, and were collected under three categories: (1) hygiene practices (wearing a face mask, washing hands more frequently with soap and water, using hand sanitiser more regularly, disinfecting the home, covering nose and mouth when

sneezing or coughing) (2) travel avoidance (travel to affected countries and travel to areas inside and outside the UK, regardless of whether they were affected) (3) social distancing (avoiding public transport, social events, going out in general, going to hospital or other healthcare settings, crowded places, and contact with people who have a fever or respiratory symptoms).

Ability and willingness to self-isolate were asked with the following questions:

- If you were advised to do so by a healthcare professional, would you be:
    a. able to self-isolate? (Yes, I would / No, I wouldn't / Don't know)
    b. willing to self-isolate? (Yes, I would / No, I wouldn't / Don't know)

At the time the survey was conducted, Public Health England's operational definition of 'self-isolation' was "*if you have symptoms of coronavirus infection (COVID-19), however mild, do not leave your home (even to buy food or essentials) or have any visitors for 7 days from when your symptoms started. This includes not going to work, school or other public places, and avoiding public transport or taxis. Self-isolation is the same as voluntary quarantine.*"[25]

We worked with YouGov to optimise question clarity and ease of understanding for the UK population.

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: http://www.imperial.ac.uk/medicine/departments/school-public-health/infectious-disease-epidemiology/mrc-global-infectious-disease-analysis/covid-19/covid-19-scientific-resources/

Data Collection

Data were collected between 1630 GMT on 17 March 2020 and 1030 GMT on 18 March 2020. Participants identified for the sample were sent an email with a survey link. YouGov returned the anonymised data set to the Imperial College London research team for analysis.

Data Analysis

Analyses were conducted in Stata 15 and SPSS version 25.

Descriptive statistics for all variables present the number of respondents and the weighted percentages. Percentages were weighted for age, sex, region and ethnicity to account for variation in response rates, so as to be representative of the population (18+ years) of the UK. Details of the weighting approach used and the sample population profile are in the Supplement, S1.

For analysis, age, collected as discrete count in years, was collapsed into four age bands routinely used in the UK to report COVID-19 related data. Ethnicity data were collected using the 18 response categories used in the UK 2011 Census [23] but were collapsed into two categories (white / Black, Asian and minority ethnic (BAME)) because of small numbers of respondents in BAME groups.

Robust Poisson regression, by estimating relative risk (RR), was used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) ability and (4) willingness to self-isolate. Adoption of social distancing measures was proxied by respondents reporting to have avoided crowded places and social events to protect themselves or others from COVID-19. RR is a relative measure of effect, which allows the comparison of a dependant variable (outcome) in one group relative to a reference group within the independent (explanatory) variable. For our outcomes of interest, an RR>1 would indicate that the group was more likely to (1) adopt social distancing measures, (2) be able to work from home, and (3) be able and (4) willing to self-isolate relative to the reference group for that independent variable.

Age and sex were retained in all the regression models as they are considered important confounders. Including as many explanatory variables as possible can dilute true associations and lead to large standard errors with wide and imprecise confidence intervals, or, conversely, identify spurious associations. The conventional technique is to first run the univariate analyses and then use only those variables which meet a pre-set cut-off for significance to run a multivariable model. This cut-off is often more liberal than the conventional cut-off for significance (e.g., $P < 0.20$, instead of the usual $P < 0.05$) since its purpose is to identify potential predictor variables rather than to test a hypothesis [26]. Therefore, only variables that appeared to be associated ($p<0·20$) in the unadjusted analyses were considered in the adjusted analyses. Adjusted relative risk (aRR) and 95% confidence intervals (CI) were estimated. Associations with a p-value <0·05 in the adjusted analyses

were considered to be statistically significant. We did not adjust our p-values for multiple comparisons to reduce type I errors for null associations because this increases type II errors for those associations that are not null [27,28]. Not adjusting for multiple comparisons in the context of this study is preferable because it will result in less errors of interpretation as the data under examination are not random numbers but actual observations on people. Furthermore, in the context of a global pandemic caused by an emerging infectious disease it may be better to explore leads that may turn out to be wrong than risk missing possibly important findings that could provide insights for control of the virus.

We tested for collinearity between education level, employment status, household income, savings, and household tenure. For these categorical variables, collinearity was measured by examining bivariate relationships using Pearson's Chi-squared tests. Where collinearity was detected we ran separate adjusted regression analyses for those variables, using only other explanatory variables in those models that were not strongly correlated.

Patient and Public Involvement

Prior to conducting the study, we distributed an online feedback form to communities across the UK using local networks of public partners and contacts, Twitter and via VOICE-global.org, an online platform for public involvement in research established by Newcastle University. We received 420 responses, including 328 from members of the public. The experiences and feedback shared guided our study design and scope, including the phrasing of the survey tool's closed-ended questions and the refinement of pre-populated answer choices.

Study results will be shared with the public both by posting on the VOICE-global.org news page, on the research team's website, and through direct mail with those who consented to be contacted about our research and involvement activity.

Ethical approval

The Imperial College London Research Ethics Committee approved the study (Ref 20IC5861). Informed consent was obtained from those who chose to complete the survey after having read introductory information on its content and purpose.

Results

The overall sample is described in Table 1. There was lower response among people from minority ethnic groups and older age groups compared to the UK population profile (Supplement, S1 for full details of the sample profile compared to UK population profile). In summary, of the 2,108 respondents, 11·1% were 18 to 24 years old, and 13·5% were 70 years or older. The majority of respondents were white (93·9%). In total, 43·4% were in full-time work and 14·1% were in part-time work.

Overall, 77·4% (1,640/2,108) of respondents reported being worried about the COVID-19 outbreak in the UK. None of the 2,108 respondents had previously tested positive for COVID-19, and 47·5% (979/2,108) believed that it was likely they would be infected at some point in the future under the UK Government's preventive measures. If infected, just over half (56·9%) of respondents would expect to be moderately severely affected (e.g. may need self-care and rest in bed) (Table 1).

Accordingly, 94·2% of adults reported taking at least one preventive measure (to protect oneself and others) against COVID-19 infection: 85·8% washed their hands with soap more frequently; 56·5% avoided crowded areas; 54·5% avoided social events and 39·2% avoided public transport (Figure 1). Most reported that their behaviour change was in response to government guidance (71·3%). Preventive measures perceived to be most effective were washing hands more frequently with soap and water (92·5%), avoiding contact with people who have a fever or respiratory symptoms (91·4%), and covering nose and mouth when sneezing or coughing (90·0%) (Figure 1). Perceived effectiveness of preventive measures was higher than actual adoption for all measures. This was particularly marked for social distancing measures (Figure 1).

Adoption of social-distancing measures

Overall, 45·2% of respondents reported adopting social distancing measures (avoiding crowded places and avoiding social events) to protect themselves or others from COVID-19.

Table 2 shows the regression analysis results for adoption of social-distancing measures. Being 70 years or older (64·2% vs. 38·4%; aRR:1·2; 95% CI:1.1,1·5) was positively associated with greater adoption compared to younger adults aged 18 to 34 years. Compared with those who were married, in a civil partnership, or living as married (48·4%), respondents who were separated, divorced, or widowed (44·1%; aRR:0·75; 95% CI:0·64,0·87) or never

married (38·4%; aRR:0·74; 0·63,0·88) were less likely to have adopted social distancing measures to prevent transmission of COVID-19. Respondents with £100 savings or less were a fifth less likely to have adopted social distancing measures compared to those with £25,000 or more in savings (43.5% vs. 48.4%; aRR:0·83; 95% CI:0·73,0·95) (Table 2).

Table 1. Demographics, socio-economic characteristics and COVID-19 risk perceptions, N=2,108

Characteristic	No.	Weighted %
Demographic and socio-economic		
Age (years)		
18-24	218	11·1
25-34	294	14·4
35-44	396	19·3
45-54	355	17·5
55-69	519	24·2
70 or above	326	13·5
Sex		
Male	987	48·0
Female	1094	50·7
Prefer not to say	27	1·3
Ethnicity		
White	1985	93·9
Asian/Asian British	48	2·4
Black / African / Caribbean / Black British	20	1·0
Other ethnic group, including mixed/multiple ethnic groups	39	1·9
Prefer not to say	16	0·77
Marital status		
Married, civil partnership, or living as married	1283	60·3
Separated, divorced, or widowed	270	12·2
Never married	545	27·1
Prefer not to say	10	0·45
Area of residence		
London	239	13·1
North	522	23·3
Midlands	531	25·2
South	485	22·5
N. Ireland, Scotland, Wales	331	15·9
Education		
No formal qualification	121	5·5
Secondary-level qualification	859	42·1
Post-secondary-level, below bachelor	148	6·9
Bachelor-level or above	664	30·8
Other technical, professional or higher qualification	245	11·2
Don't Know	32	1·6
Prefer not to say	39	2·0
Employment status		
Working full time	889	43·4
Working part time	292	14·1
Full time student	112	5·6
Retired	553	23·6
Unemployed or not working	207	10·5

Other	55	2·8
Household income		
<£20,000	440	20·7
£20,000 to £29,999	355	16·8
£30,000-£49,999	472	22·4
£50,000 and over	429	20·6
Don't know	103	5·1
Prefer not to say	309	14·4
Savings		
Less than £100	278	13·6
£100 to £999	242	11·8
£1,000 to £4,999	305	14·5
£5,000 to £24,999	359	16·6
£25,000 or more	359	16·6
Prefer not to say	565	26·9
Housing tenure		
Own – outright	681	30·4
Own – mortgage/shared ownership	639	30·8
Rent – private landlord	319	15·6
Rent – local authority/housing association	219	10·7
Live with parents, family or friends	215	10·7
Other	35	1·8
COVID-19 risk perceptions		
Level of worry about the current COVID-19 outbreak in the UK		
Worried	1640	77·4
Not worried	454	21·9
Don't know	14	0·74
Perceived susceptibility[a]		
Likely	979	47·5
Neither likely or unlikely	547	26·2
Unlikely	337	15·9
Don't know	220	10·5
Perceived severity[b]		
I would expect it to be life-threatening	103	4·7
I would expect it to be severe (e.g. may need care and treatment in hospital)	306	14·2
I would expect it to be moderate (e.g. may need self-care and rest in bed)	1180	56·9
I would expect it to be mild (e.g. can go about daily tasks normally)	351	17·2
I would expect to have no symptoms	33	1·7
Don't know	110	5·3

[a]Under the UK government's current preventive measures (at the time of the study), how likely or unlikely do you think it is you will be infected with the coronavirus (COVID-19) at any point in the future?

[b]Please imagine you were infected with coronavirus (i.e. COVID-19), which of the following do you think would best apply?

Figure 1. Perceived effectiveness and actual adoption of preventative measures to prevent transmission of COVID-19; N=2,108

Table 2. Social distancing behaviour and ability to work from home by a range of sociodemographic factors, N=2,108

	Social distancing measures being taken yes vs no [a]				Able to work from home yes vs no (N=1,149) [d]			
	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Social distancing								
Yes	969	45·2						
No	1,139	54·8						
Ability to work from home								
Yes					540	44·3		
No					609	53·0		
Don't Know					32	2·7		
Age								
18-34	202	38·4	Ref	Ref[b]	154	48·0	Ref	Ref[e]
35-49	229	40·8	1·1 (0·91-1·2)	0.86 (0·74-1·0)	220	48·0	1·0 (0·86-1·2)	0·98 (0·94-1·3)
50-69	329	46·4	**1·2 (1·1-1·4)****	0.81 (0·73-1·0)	151	39·9	**0·83 (0·70-0·99)***	0·90 (0·81-1·1)
70 or older	209	64·2	**1·7 (1·5-1·9)*****	**1·2 (1·1-1·5)***	15	53·9	1·1 (0·78-1·6)	1·1 (0·96-1·7)
Sex								
Male	436)	42·9	Ref	Ref[b]	280	46·1	Ref	Ref[e]
Female	519	47·4	**1·1 (1·0-1·2)***	1·0 (0·88-1·2)	254	44·8	0·97 (0·85-1·1)	0·98 (0·86-1·2)
Ethnicity								
White	919	45·5	Ref	-	506	45·1	Ref	Ref[e]
Black, Asian and minority ethnic	45	42·1	0·92 (0·73-1·2)		31	54·2	1·2 (0·94-1·5)	1.0 (0·98-1·1)
Marital status								
Married, civil partnership, or living as married	628	48·4	Ref	Ref[b]	366	47·2	Ref	-
Separated, divorced, or widowed	121	44·1	0·91 (0·79-1·1)	**0·75 (0·64-0·87)*****	43	39·5	0·84 (0·65-1·1)	
Never married	214	38·4	**0·79 (0·70-0·90)*****	**0·74 (0·63-0·88)****	128	43·5	0·92 (0·79-1·1)	
Area of residence								
London	111	45·2	Ref	-	76	54·0	Ref	Ref[e]
North of England	220	41·6	0·92 (0·77-1·1)		129	44·7	0·83(0·67-1·0)	1·0 (0·76-1·2)
Midlands and East of England	249	46·0	1·0 (0·86-1·2)		123	44·4	0·82 (0·67-1·0)	1.0 (0·75-1·1)
South of England	221	45·0	0·99 (0·84-1·2)		151	49·0	0·91 (0·75-1·1)	1·0 (0·88-1·4)

N. Ireland, Scotland, Wales	168	49·9	1·1 (0·92-1·3)		61	35·2	**0·65 (0·50-0·84)****	0·76 (0·59-1·0)
Education								
Degree or above	321	48·0	Ref	-	289	62·6	Ref	Ref[f]
Post-secondary	186	46·7	0·97 (0·85-1·1)		105	47·7	**0·76 (0·65-0·89)****	**0·68 (0·59-0·79)*****
Secondary or below	436	43·7	0·91 (0·82-1·0)		137	29·4	**0·47 (0·40-0·55)*****	**0·45 (0·39-0·53)*****
Employment status								
Working full time	344	38·6	Ref	Ref[b]	439	48·9	Ref	Ref[f]
Working part time	136	46·8	**1·2 (1·0-1·4)***	1·0 (0·86-1·2)	101	35·0	**0·71 (0·60-0·85)*****	0·93 (0·84-1·2)
Full time student	43	36·3	0·94 (0·73-1·2)	1·0 (0·71-1·5)	N/A	N/A	N/A	N/A
Retired	331	59·7	**1·5 (1·4-1·7)*****	1·1 (0·90-1·3)	N/A	N/A	N/A	N/A
Unemployed / Not working	95	45·4	1·2 (0·99-1·4)	1·1 (0·90-1·4)	N/A	N/A	N/A	N/A
Household income								
£50,000 and over	178	41·0	Ref	Ref[c]	241	67·3	Ref	Ref[g]
£30,000 to £49,999	211	43·8	1·1 (0·92-1·2)	1·0 (0·87-1·2)	131	42·6	**0·63 (0·54-0·74)*****	**0·55 (0·47-0·63)*****
£20,000 to £29,999	173	48·5	**1·2 (1·0-1·4)***	1·1 (0·89-1·3)	64	30·7	**0·46 (0·37-0·57)*****	**0·41 (0·33-0·52)*****
<£20,000	218	49·0	**1·2 (1·0-1·4)***	1·0 (0·87-1·2)	31	22·7	**0·34 (0·24-0·47)*****	**0·33 (0·24-0·45)*****
Savings								
£25,000 or more	177	48·4	Ref	Ref[c]	100	59·9	Ref	Ref[g]
£5,000 to £24,999	177	48·7	1·0 (0·86-1·2)	1·1 (0·93-1·3)	131	57·6	0·96 (0·81-1·1)	0·90 (0·76-1·1)
£1,000 to £4,999	126	40·7	0·84 (0·71-1·0)	**0.76 (0·67-0.87)*****	89	43·7	**0·73 (0·59-0·90)****	**0·67 (0·54-0·83)*****
£100 to £999	91	37·4	**0·77 (0·63-0·94)***	**0·73 (0·61-0.87)*****	67	40·1	**0·67 (0·53-0·84)****	**0·64 (0·50-0·81)*****
Less than £100	122	43·5	0·90 (0·76-1·1)	**0.83 (0·73-0.95)*****	54	33·1	**0·55 (0·43-0·71)*****	**0·51 (0·39-0·67)*****
Housing tenure								
Own outright	377	55·0	Ref	Ref[c]	93	41·0	Ref	Ref[g]
Own with mortgage/shared ownership	261	40·8	**0·74 (0·66-0·83)*****	0·95 (0·82-1·1)	293	55·0	**1·3 (1·1- 1.6)****	1·0 (0·73-1.5)
Rented from private landlord	145	45·0	**0·82 (0·71-0·94)****	1·1 (0·90-1·3)	85	39·8	0·97 (0·77-1·2)	0·92 (0·83-1.1)
Rented from local authority/housing association	94	42·2	**0·77 (0·65-0·91)****	0·90 (0·75-1·1)	16	18·2	**0·44 (0·27-0·72)****	**0·45 (0·28-0·73)****
Live with parents, family, or friends	78	35·4	**0·64 (0·53-0·78)*****	0·93 (0·70-1·2)	46	43·6	1·1 (0·81-1·4)	0·79 (0·65-1·0)

[a]Those that report avoiding crowded areas AND social events; [b]Mutually adjusted for age, sex, marital status, employment status, household income, savings and housing tenure; [c]Adjusted for age, sex, marital status and employment status. [d]Excluding those who responded "Don't know"; [e]Mutually adjusted for age, sex, ethnicity, UK area of residence, education, employment status, household income, savings and housing tenure; [f]Adjusted for age, sex, ethnicity, UK area of residence and housing tenure; [g]Adjusted for age, sex, ethnicity and UK area of residence. *p<·05, **p<·01, ***p<·001

Ability to work from home

Overall, 44·3% of respondents reported being able to work from home (i.e. permitted by their employer and have the necessary equipment to do their job from home).

Respondents who held post-secondary but below degree-level (47·7%; aRR:0·68; 95% CI:0·59,0·79) and secondary or below level (29·4%; aRR:0·45; 95% CI:0·39,0·53) education qualifications were less likely to be able to work from home compared with those educated to degree level (62·6%) (Table 2). As with educational level, there was a household income and savings gradient with ability to work from home. Those with the lowest household income (<£20,000) were three times less likely to be able to work from home compared to those with household incomes of £50,000 and above (22·7% vs. 67·3%; aRR:0·33; 95% CI:0·24,0·45). Respondents with £100 savings or less were half as likely to be able to work from home compared to those with £25,000 or more in savings (33·1% vs. 59·9%; aRR:0·51; 95% CI:0·39,0·67) (Table 2). Compared with those who owned their home outright, those renting accommodation from a local authority or housing association were less likely to be able to work from home (18·2% vs. 41·0%; aRR:0·45; 95% CI:0·28,0·73).

Willingness and ability to self-isolate

Overall, perceived ability (87·0%) and willingness (87·6%) to self-isolate for 7 days if asked by a healthcare professional were high.

In terms of socio-demographic associations, there was no effect of sex on perceived ability to self-isolate (Table 3). However, women were somewhat more willing to do so than men (94·9% vs. 91·8%; aRR:1·1; 95% CI:1·0,1·2). Respondents from ethnic minority backgrounds perceived themselves to be less able to self-isolate than respondents from white backgrounds (84·8% vs. 92·1%, aRR:0.89; 95% CI:0.79 to 1.0), although they were equally willing to do so (Table 3).

Some indicators of socioeconomic status were significantly associated with perceived ability and willingness to self-isolate. Respondents who held post-secondary but below degree-level education qualifications were less willing to self-isolate (90·9% vs. 94·9% aRR:0·95; 95% CI:0·92,0·99) than respondents educated to degree level (Table 3). Those with household incomes below £20,000 were less likely to be able to self-isolate compared with those on

Table 3. Ability and willingness to self-isolate by sociodemographic factors

	Able to self-isolate yes vs no (N=2,002)[a]				Willing to self-isolate yes vs no (N=1,978) [a]			
	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Self-isolation ability/willingness								
Yes, I would	1,834	87·0			1,847	87·6		
No, I wouldn't	168	8·0			131	6·2		
Don't know	106	5·0			130	6·2		
Age								
18-34	466	90·8	Ref	Ref[b]	457	91·6	Ref	Ref[d]
35-49	494	90·0	0.99 (0·95-1·1)	1·0 (0·96-1.1)	508	94·2	1·0 (0·99-1.1)	1·0 (0·98-1.1)
50-69	614	92·2	1·0 (0·98-1·1)	1·0 (0·97-1·1)	627	93·6	1·0 (0·99-1·1)	1·0 (0·96-1.1)
70 or older	262	94·9	**1·1 (1·0-1.2)***	1·0 (0·96-1.1)	255	94·4	1·0 (0·99-1.1)	1·0 (0·96-1.1)
Sex								
Male	878	90·7	Ref	Ref[b]	878	91·8	Ref	Ref[d]
Female	957	92·5	1·0 (0·99-1·1)	1·0 (0·98-1·1)	969	94·9	**1·1 (1·0-1.2)****	**1·1 (1·0-1.2)***
Ethnicity								
White	1,737	92·1	Ref	Ref[b]	1,751	93·7	Ref	Ref[d]
Black, Asian and minority ethnic	89	84·8	**0·92 (0·84-0·99)***	**0·89 (0·79-1·0)***	86	87·8	0·94 (0·87-1.0)	0·96 (0·87-1·1)
Marital status								
Married, civil partnership, or living as married	1,128	92·3	Ref	-	1,143	94·5	Ref	Ref[d]
Separated, divorced, or widowed	215	90·7	0·98 (0·94-1·2)		219	92·8	0·98 (0·95-1·1)	0·98 (0·93-1·1)
Never married	482	90·3	0·97 (0·95-1·1)		477	91·0	**0·96 (0·93-0·99)***	0·99 (0·95-1·1)
Area of residence								
London	241	91·6	Ref	-	243	92·7	Ref	-
North of England	427	91·2	0.99 (0·95-1·1)		430	93·7	1·0 (0·97-1·1)	
Midlands and East of England	465	93·0	1·0 (0·97-1.2)		465	93·9	1·0 (0·97-1·1)	
South of England	408	89·5	0·98 (0·93-1·1)		411	92·2	0·99 (0·95-1·0)	
N. Ireland, Scotland, Wales	294	92·7	1·0 (0·96-1·2)		297	94·3	1·0 (0·97-1.1)	
Education								
Degree or above	584	93·1	Ref	-	591	94·9	Ref	Ref[e]

Post-secondary	332	90·2	0·97 (0·93-1·1)		329	90·9	**0·96 (0·92-0·99)***	**0·95 (0·92-0·99)***
Secondary or below	863	91·3	0·98 (0·95-1·1)		873	93·6	0·98 (0·96-1·0)	1·0 (0·97-1·0)
Employment status								
Working full time	799	91·4	Ref	Ref[b]	804	93·6	Ref	-
Working part time	255	90·4	0·99 (0·95-1·0)	0·98 (0·93-1·0)	263	92·9	0·99 (0·96-1·0)	
Full time student	105	93·8	1·0 (0·97-1.1)	1·0 (0·94-1.1)	97	89·0	0·95 (0·88-1·0)	
Retired	450	95·1	**1·1 (1·0-1.2)****	1·0 (0·96-1·1)	444	94·7	1·0 (0·98- 1.1)	
Unemployed or not working	185	89·8	0·98 (0·93-1·0)	1·0 (0·93-1·1)	191	94·1	1·0 (0·96-1.1)	
Household income								
£50,000 and over	405	95·5	Ref	Ref[c]	393	94·7	Ref	-
£30,000 to £49,999	417	90·7	**0·95 (0·92-0·98)****	**0·95 (0·92-0·98)****	424	93·6	0·99 (0·95-1·2)	
£20,000 to £29,999	311	92·6	0·97 (0·94-1·1)	0·96 (0·93-1·0)	308	91·9	0·97 (0·93-1·1)	
<£20,000	363	88·3	**0·93 (0·89-0·96)*****	**0·92 (0·88-0·96)*****	383	93·0	0·98 (0·95-1·1)	
Savings								
£25,000 or more	329	95·6	Ref	Ref[c]	318	94·1	Ref	Ref[f]
£5,000 to £24,999	319	95·2	1.0 (0·96-1·1)	1·0 (0·97-1.1)	317	95·8	1·0 (0·98-1.1)	1·0 (0·98-1·1)
£1,000 to £4,999	274	92·3	0·96 (0·93-1·1)	0·99 (0·95-1·0)	272	92·8	0·98 (0·94-1·1)	0·99 (0·96-1·0)
£100 to £999	217	90·0	**0·94 (0·90-0·98)***	0·97 (0·92-1·1)	221	94·8	1·0 (0·97-1.1)	1·0 (0·96-1.1)
Less than £100	232	84·4	**0·88 (0·83-0·93)*****	**0·90 (0·85-0·96)****	250	90·9	0·96 (0·92-1·0)	0·96 (0·91-1·1)
Housing tenure		93·8						
Own outright	576	92·1	Ref	Ref[c]	575	95·0	Ref	Ref[g]
Own with mortgage/shared ownership	571	89·1	0·98 (0·95-1·0)	1.0 (0·96-1·1)	584	95·0	1.0 (0·97-1·0)	1.0 (0·97-1·1)
Rented from private landlord	277		**0·95 (0·91-0·99)***	0·97 (0·92-1·0)	297	94·3	0·99 (0·96-1·0)	1.0 (0·95-1·1)
Rented from local authority/housing association	188	87·9 92·9	**0·94 (0·89-0·99)***	0·97 (0·91-1·0)	188	90·0	**0·94 (0·90-0·99)***	**0·94 (0·89-0·99)****
Live with parents, family, or friends	197		0·99 (0·95-1·1)	1·0 (0·97-1.1)	178	88·1	**0·92 (0·88-0·98)***	0·95 (0·89-1·0)

[a]Excluding those who responded "Don't know"; [b]Mutually adjusted for age, gender, ethnicity, employment status, household income, savings, and housing tenure; [c]Adjusted for age, gender, ethnicity, and employment status; [d]Mutually adjusted for age, gender, ethnicity, marital status, education, savings, and housing tenure; [e]Adjusted for age, gender, ethnicity, marital status, and housing tenure; [f]Adjusted for age, gender, ethnicity, and marital status; [g]Adjusted for age, gender, ethnicity, marital status, and education; *p<·05, **p<·01, ***p<·001

household incomes of £50,000 and above (88·3% vs. 95·5%; aRR:0·92; 95% CI:0·88,0·96). Similarly, respondents with less than £100 in savings were less likely to be able to self-isolate compared with those with savings of £25,000 or more (84·8% vs. 95·6%; aRR:0·90; 95% CI:0·85,0·96). There was no effect on willingness to self-isolate by household income or amount of savings (Table 3).

Those in accommodation rented from a private landlord, local authority, or housing association were less likely to report being able to self-isolate, although this association was no longer significant when other sociodemographic factors were adjusted for. In terms of willingness to self-isolate, respondents renting accommodation from a local authority or housing association were less likely to be willing to self-isolate compared with those who owned their home outright (aRR:0·94; 95% CI:0·89,0·99) (Table 3).

Discussion

This study reports on the perceptions and behaviour of the UK adult population in the two days following the UK Government's introduction of recommendations on social distancing on March 16 2020 [6]. We found high levels of self-reported behaviour change. Notably, the most-adopted measures, washing hands more frequently with soap and water, using hand sanitiser, and covering nose and mouth when sneezing or coughing, prominently featured in national public health campaigns from relatively early on in the epidemic [4], and mirrors results seen in previous pandemics [29]. However, there were marked differences between the perceived effectiveness and adoption of NPIs. This suggests that lack of knowledge on what measures are effective against COVID-19 is not a key driver of compliance in the UK population. In contrast, a similar study conducted in Hong Kong showed comparatively high perceived effectiveness and adoption of preventive measures [24].

Our results highlighted significant differences across demographic and socioeconomic strata for social distancing behaviour, ability to work from home, and the ability and willingness of people to self-isolate. There was a strong association between socioeconomic deprivation and ability to adopt NPIs. Although willingness to self-isolate was high overall, those from more disadvantaged backgrounds were less likely to be able to work from home or self-isolate if needed, suggesting the existence of structural barriers to adopting preventive behaviours in these groups.

The strength of this study is in the representative sample of the UK adult population, the ability to achieve our sample size quickly, and the timeliness in relation to changing government recommendations. However, social distancing measures were only brought in two days before the survey. Therefore, there may have not been enough time for people to fully implement these measures prior to their participation in the study. But many employers had already begun allowing staff to work from home in the week prior to the UK Government's announcement, and ability and willingness to self-isolate do not measure behaviour change directly but intent. So, we believe our study does indeed measure attitudes and behaviours based on the most recent advice at the time of the survey. Social desirability bias is also possible given that participants were asked whether they were complying with government restrictions. However, this is less of an issue with online surveys where respondents are assured anonymity and answer questions in the privacy of their own home without any live human interaction. In addition, our sampling approach is prone to selection bias, for example by excluding participants without internet access and non-English speakers, and sampling from a panel of individuals who have specifically opted in to participate in online research activities. As in almost all population surveys, our study had unequal participation, with lower response among people from minority ethnic groups and older age groups. We re-weighted the sample to account for such differential response, although this may not have overcome unknown participation biases. Furthermore, surveys collecting self-report data are generally subject to limitations including honesty, introspective ability, and interpretation of the questions. The survey tool consisted of predominantly closed-ended questions. Thus, we were unable to explore responses in more depth.

Our findings highlight the stark choices faced by those in lower socioeconomic groups and suggest that unless the government intervenes to support these individuals, the impact of this epidemic will likely be felt unequally in our society. Not only this, but if a large proportion of the population continues to work while unwell, low compliance will render the various forms of social distancing less effective, as low-income workers are forced to choose between financial and physical health. Indeed, this behaviour has already been observed in the workplace in previous pandemics: workers without access to paid sick leave were more likely to work while unwell than those with paid sick leave [30]. A study in China after the H7N9 epidemic found that only 7% of people reported willingness to self-quarantine [31].

Also, during the Middle East Respiratory Syndrome (MERS) outbreak in South Korea in 2015, there was heterogeneous uptake of preventive interventions [32].

In the absence of a vaccine and treatments over the short-term, high compliance with social distancing, self-isolation and household quarantine is paramount to reduce transmission and the impact of COVID-19. NPI compliance, risk perception and behaviour are not consistent across cultures, social status or time. Indeed, previous studies have shown that perceptions and behaviours often change over time [29]. Therefore, current modelling projections of the impact of NPIs on morbidity and mortality are always provisional [7]. Future COVID-19 models should explore the variation captured in this and previous studies to better estimate the impact of differential uptake of NPIs in the UK and beyond. It is also important to monitor behaviour throughout the epidemic to know when to implement further public health messaging, and when further or alternative government actions might be required, to mitigate falling compliance.

Conclusions and policy implications

Our findings highlight that those most economically disadvantaged in society are less able to comply with certain NPIs, likely in part due to their financial situation. Whilst one approach may be to better tailor public health messaging to this subpopulation, this must be done alongside considered fiscal and monetary policy to mitigate the financial costs of following government public health advice. Therefore, it is imperative that the UK Government, and governments around the world, quickly develop and implement policies to support the most vulnerable, in a bid to minimise the long-term social and economic harm caused by COVID-19. Government policy should recognise the disparity in impact across socioeconomic groups, particularly across the labour market, and should aim to support workers equitably across the income spectrum. This would likely help increase compliance across the population to the levels required to suppress transmission and thereby reduce the strain on national health services, both in the UK and abroad. Although the UK Government has since announced a range of measures to support public services, individuals, and businesses, in part to facilitate compliance with current lockdown measures [33], it is uncertain how long these protections will be in place for and whether they will continue once lockdown restrictions are lifted.

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Contributors

CJA, LB, RR, PP and HW designed the study. CJA, JWE and CV analysed the data and performed the statistical analyses. CJA, LB, RR, CV and HW drafted the initial manuscript. All authors reviewed the drafted manuscript for critical content and approved the final version. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. CJA and HW are the guarantors.

Declaration of interests

The authors declare that they have no know competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data sharing

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/news--wuhan-coronavirus/covid-19-resources/

The data used for the analyses are available from the corresponding author on request.

References

1. World Health Organisation. Rolling updates on coronavirus disease (COVID-19) 2020 [Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.

2. ECDC. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – seventh update Stockholm; 2020 25 March 2020

3. Public_Health England. Weekly Coronavirus Disease 2019 (COVID-19) Surveillance Report: Summary of COVID-19 surveillance systems 2020 [Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/888254/COVID19_Epidemiological_Summary_w22_Final.pdf.

4. Russell P. New Coronavirus: UK Public Health Campaign Launched. Medscape. 2020.

5. Department of Health and Social_Care. Coronavirus (COVID-19) action plan 2020 [Available from: https://www.gov.uk/government/publications/coronavirus-action-plan.

6. UK Government. PM statement on coronavirus: 16 March 2020 2020 [Available from: https://www.gov.uk/government/speeches/pm-statement-on-coronavirus-16-march-2020.

7. Ferguson NM, Laydon D, Nedjati-Gilani G, et al. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand. 2020.

8. Cowling BJ, Ng DMW, Ip DKM, et al. Community psychological and behavioral responses through the first wave of the 2009 influenza A(H1N1) pandemic in Hong Kong. The Journal of Infectious Diseases. 2010;202(6):867-76.

9. Agüero F, Adell MN, Pérez Giménez A, López Medina MJ, Garcia Continente X. Adoption of preventive measures during and after the 2009 influenza A (H1N1) virus pandemic peak in Spain. Prev Med. 2011;53(3):203-6.

10. Rubin GJ, Amlôt R, Page L, Wessely S. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross sectional telephone survey. BMJ. 2009;339:b2651.

11. Rubin GJ, Potts HW, Michie S. The impact of communications about swine flu (influenza A H1N1v) on public responses to the outbreak: results from 36 national telephone surveys in the UK. Health technology assessment (Winchester, England). 2010;14(34):183-266.

12. Lau JTF, Griffiths S, Choi KC, Tsui HY. Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. BMC Infectious Diseases. 2010;10(1):139.

13. Eastwood K, Durrheim D, Francis JL, et al. Knowledge about pandemic influenza and compliance with containment measures among Australians. Bull World Health Organ. 2009;87(8):588-94.

14. Lohiniva AL, Sane J, Sibenberg K, Puumalainen T, Salminen M. Understanding coronavirus disease (COVID-19) risk perceptions among the public to enhance risk communication efforts: a practical approach for outbreaks, Finland, February 2020. Euro Surveill. 2020;25(13).(doi):10.2807/1560-7917.ES.2020.25.13.2000317.

15. Gesser-Edelsburg A, Cohen R, Hijazi R, Abed Elhadi Shahbari N. Analysis of Public Perception of the Israeli Government's Early Emergency Instructions Regarding COVID-19: Online Survey Study. J Med Internet Res. 2020;22(5):e19370. doi: 10.2196/.

16. Olapegba PO, Ayandele O. Survey data of COVID-19-related Knowledge, Risk Perceptions and Precautionary Behavior among Nigerians. Data Brief. 2020;8(105685):105685.

17. Motta Zanin G, Gentile E, Parisi A, Spasiano D. A Preliminary Evaluation of the Public Risk Perception Related to the COVID-19 Health Emergency in Italy. Int J Environ Res Public Health. 2020;17(9).(pii):ijerph17093024. doi: 10.3390/ijerph.

18. Kin On K, Kin Kit L, Henry Ho Hin C, et al. Community Responses during Early Phase of COVID-19 Epidemic, Hong Kong. Emerging Infectious Disease journal. 2020;26(7).

19. McFadden SM, Malik AA, Aguolu OG, Willebrand KS, Omer SB. Perceptions of the adult US population regarding the novel coronavirus outbreak. PLoS One. 2020;15(4):e0231808. doi: 10.1371/journal.pone.. eCollection 2020.

20. Husnayain A, Shim E, Fuad A, Su EC-Y. Understanding the Community Risk Perceptions of the COVID-19 Outbreak in South Korea: Infodemiology Study. J Med Internet Res. 2020;22(9):e19788.

21. Atchison CJ, Bowman L, Eaton JW, et al. Report 10: Public Response to UK Government Recommendations on COVID-19: Population Survey, 17-18 March 2020 2020.

22. YouGov. ESOMAR28: 28 questions to help online research buyers14 March 2020. Available from: http://doc.ukdataservice.ac.uk/doc/7647/mrdoc/pdf/7647_methodology_esomar_28.pdf.

23. Office for National Statistics. UK 2011 census data [Available from: https://www.ons.gov.uk/census/2011census.

24. Kwok KO, Li KK, Chan HHH, et al. Community responses during the early phase of the COVID-19 epidemic in Hong Kong: risk perception, information exposure and preventive measures. medRxiv. 2020.

25. Fenton K, Pawson E, de Souza-Thomas L. Beyond the Data: Understanding the Impact of COVID-19 on BAME Communities. PHE. Online report. 2020 [Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/892376/COVID_stakeholder_engagement_synthesis_beyond_the_data.pdf.

26. Ranganathan P, Pramesh CS, Aggarwal R. Common pitfalls in statistical analysis: Logistic regression. Perspect Clin Res. 2017;8(3):148-51.

27. Rothman KJ. No adjustments are needed for multiple comparisons. Epidemiology (Cambridge, Mass). 1990;1(1):43-6.

28. Feise RJ. Do multiple outcome measures require p-value adjustment? BMC Medical Research Methodology. 2002;2(1):8.

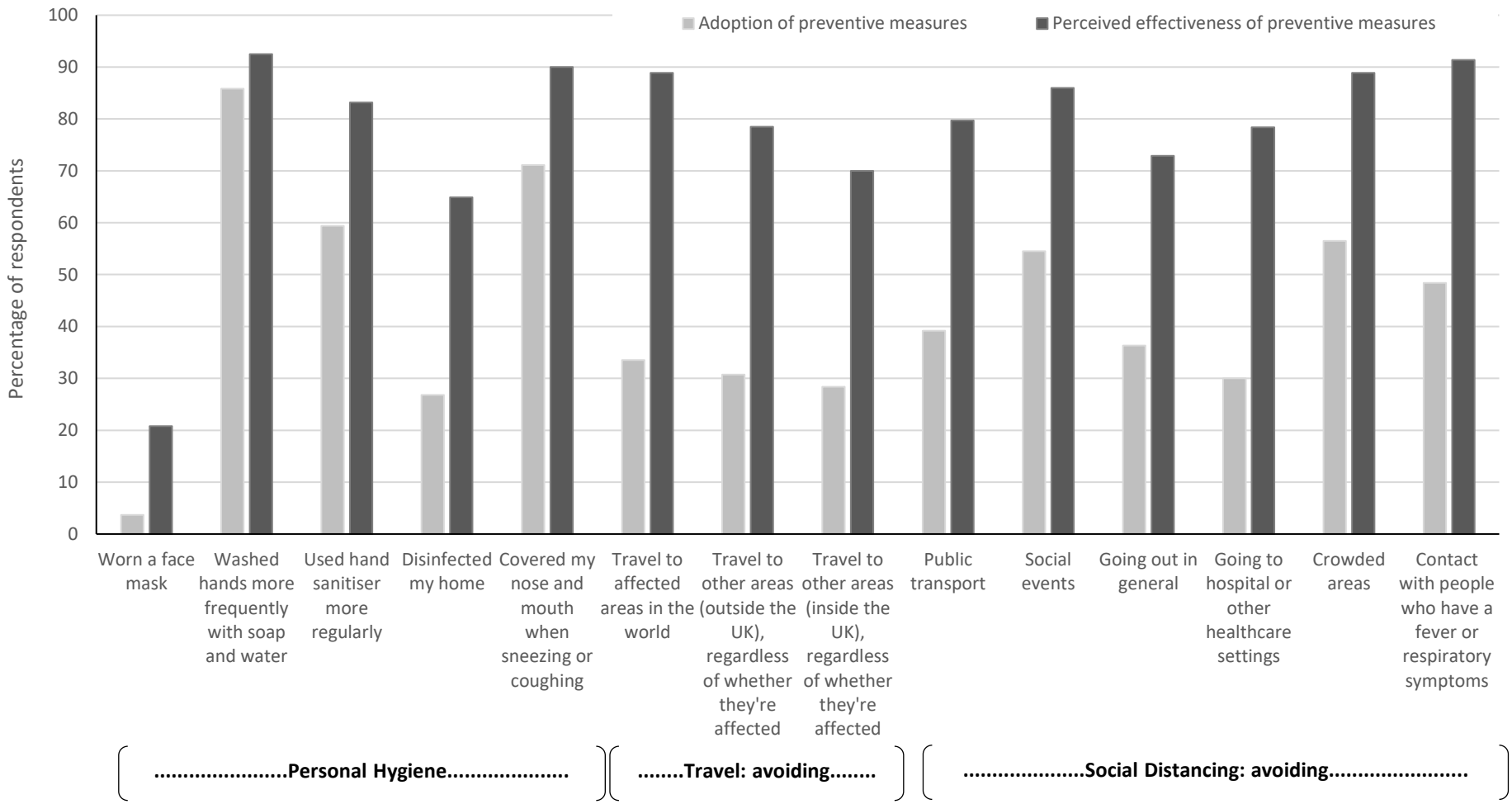
29. Bults M, Beaujean DJ, Richardus JH, Voeten HA. Perceptions and behavioral responses of the general public during the 2009 influenza A (H1N1) pandemic: a systematic review. Disaster Med Public Health Prep. 2015;9(2):207-19. doi: 10.1017/dmp.2014.160.

30. Ahmed F, Zviedrite N, Uzicanin A. Effectiveness of workplace social distancing measures in reducing influenza transmission: a systematic review. BMC Public Health. 2018;18(1):518. doi: 10.1186/s12889-018-5446-1.

31. Goodwin R, Sun S. Public perceptions and reactions to H7N9 in Mainland China. J Infect. 2013;67(5):458-62. doi: 10.1016/j.jinf.2013.06.014. Epub Jul 5.

32. Jang WM, Cho S, Jang DH, et al. Preventive Behavioral Responses to the 2015 Middle East Respiratory Syndrome Coronavirus Outbreak in Korea. Int J Environ Res Public Health. 2019;16(12).(pii):ijerph16122161. doi: 10.3390/ijerph.

33. UK Government. Support for those affected by Covid-19 2020 [Available from: https://www.gov.uk/government/publications/support-for-those-affected-by-covid-19.


Adoption of preventive measures
Perceived effectiveness of preventive measures
Percentage of respondents
100
90
80
70
60
50
40
30
20
10
0
Worn a face mask
Washed hands more frequently with soap and water
Used hand sanitiser more regularly
Disinfected my home
Covered my nose and mouth when sneezing or coughing
Travel to affected areas in the world
Travel to other areas (outside the UK), regardless of whether they're affected
Travel to other areas (inside the UK), regardless of whether they're affected
Public transport
Social events
Going out in general
Going to hospital or other healthcare settings
Crowded areas
Contact with people who have a fever or respiratory symptoms
.....Personal Hygiene.....
.....Travel: avoiding.....
.....Social Distancing: avoiding.....

Sample – Weighting Strategy

The weighting approach used rim weighting to adjust to population estimates of: age by sex; UK geographical region counts; ethnic group.

The age by sex and region counts were extracted from the ONS mid-year population estimates (1), and the ethnic group counts from the Labour Force Survey (Annual Population Survey) (2). To allow for the different sources of population estimates, the rim weighting was carried out on the proportions rather than population totals.

Age was grouped into seven categories: 18 to 24; 25 to 34; 35 to 44; 45 to 54; 55 to 64; 65 to 74; 75 or older. So the age and sex groups had 14 categories.

The reported ethnicity was grouped into nine categories: white; mixed / multiple ethnic groups; Indian; Pakistani; Bangladeshi; Chinese; any other Asian background; black African / Caribbean / other; and any other ethnic group or missing.

The rim weighting was carried out in two stages. At the first stage, the sample was weighted to region counts and age by sex groups only. This put the sample back into the correct proportion for UK geographical regions which corrects for the differential non-response. In the same stage, the age and sex groups were also adjusted to make sure that the final weighted profile was as close to the population as possible.

The second stage of rim weighting adjusted to all four measures, using the first stage weights as the starting weights. The adjustment factor between the first and second stage weights were trimmed at the 1st and 99th percentiles to dampen the extreme weights which improves efficiency. The final weights were calculated as the first stage weights multiplied by the trimmed adjustment factor for the second stage.

Sample profile

	Population of United Kingdom Profile	COMPLETED SURVEY - UNWEIGHTED (%)	COMPLETED SURVEY - WEIGHTED (%)
GENDER			
Male	48.9%	47.4%	48.6%
Female	51.1%	52.6%	51.4%
AGE			
18 to 24	10.9%	10.3%	11.1%
25 to 34	17.3%	14.0%	14.4%
35 to 44	16.1%	18.8%	19.3%
45 to 54	17.5%	16.8%	17.5%
55 to 64	15.0%	13.7%	14.6%
65 to 74	12.6%	20.5%	17.9%
75+	10.5%	6.0%	5.2%
REGION			
North East	4.0%	4.7%	4.4%
North West	11.0%	11.7%	10.9%
Yorkshire & Humber	8.2%	8.4%	8.0%
East Midlands	7.2%	7.5%	7.7%
West Midlands	8.9%	8.3%	8.4%
East of England	9.3%	9.4%	9.1%
London	13.4%	11.3%	13.1%
South East	13.7%	13.1	13.0%
South West	8.4%	9.9%	9.6%

N. Ireland, Scotland, Wales	15.7%	15.7%	15.9%
ETHNICITY			
White	86.3%	94.2%	93.9%
Mixed/Multiple ethnic groups	1.1%	1.6%	1.7%
Indian	2.9%	1.0%	1.1%
Pakistani	1.9%	0.52%	0.54%
Bangladeshi	0.8%	0.14%	0.15%
Chinese	0.5%	0.43%	0.46%
Any other Asian background	1.2%	0.14%	0.16%
Black/African/Caribbean/Black British	3.3%	0.95%	1.0%
Other ethnic group / DK	1.9%	1.0%	1.0%

REFERENCES

1. Office for National Statistics. Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019 2020 [Available from: www.ons.gov.uk/releases/populationestimatesfortheukenglandandwalesscotlandandnorthernirelandmid2019.
2. Office for National Statistics. Annual Population Survey/Labour Force Survey 2020 [Available from: https://www.nomisweb.co.uk/sources/aps.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **PAGE 1 and 2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **PAGE 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **PAGE 4**
Objectives	3	State specific objectives, including any prespecified hypotheses **PAGE 4**
Methods		
Study design	4	Present key elements of study design early in the paper **PAGE 5-6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **PAGE 5-6**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **PAGE 5-6**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **PAGE 5-7**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **PAGE 5-6**
Bias	9	Describe any efforts to address potential sources of bias **PAGE 5 and 7**
Study size	10	Explain how the study size was arrived at **PAGE 5**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **PAGE 7**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **PAGE 7**
		(*b*) Describe any methods used to examine subgroups and interactions **PAGE 7**
		(*c*) Explain how missing data were addressed **N/A**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **PAGE 7**
		(*e*) Describe any sensitivity analyses **N/A**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **PAGE 8**
		(b) Give reasons for non-participation at each stage **N/A**
		(c) Consider use of a flow diagram **N/A**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **PAGE 8-15**
		(b) Indicate number of participants with missing data for each variable of interest **Tables 1-3**
Outcome data	15*	Report numbers of outcome events or summary measures **PAGE 8-15**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **PAGE 11-15; Tables 2-3**

		(*b*) Report category boundaries when continuous variables were categorized **PAGE 8-15; Tables 1-3**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **N/A**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **PAGE 10-15; Tables 2-3**
Discussion		
Key results	18	Summarise key results with reference to study objectives **PAGE 16**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **PAGE 17**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **PAGE 16-18**
Generalisability	21	Discuss the generalisability (external validity) of the study results **PAGE 17-18**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **PAGE 19**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Early perceptions and behavioural responses during the COVID-19 pandemic: A cross-sectional survey of UK Adults

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Early perceptions and behavioural responses during the COVID-19 pandemic: A cross-sectional survey of UK Adults

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Keywords: COVID-19, novel coronavirus, epidemic, behavioural response, risk perceptions

ABSTRACT

Objective: To examine risk perceptions and behavioural responses of the UK adult population during the early phase of the COVID-19 epidemic in the UK.

Design: A cross-sectional survey

Setting: Conducted with a nationally representative sample of UK adults within 48 hours of the UK Government advising the public to stop non-essential contact with others and all unnecessary travel.

Participants: 2,108 adults living in the UK aged 18 years and over. Response rate was 84.3% (2,108/2,500). Data collected between March 17 and 18 2020.

Main outcome measures: Descriptive statistics for all survey questions, including number of respondents and weighted percentages. Robust Poisson regression used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) ability and (4) willingness to self-isolate.

Results Overall, 1,992 (94.2%) respondents reported at least one preventive measure: 85.8% washed their hands with soap more frequently; 56.5% avoided crowded areas and 54.5% avoided social events. Adoption of social-distancing measures was higher in those aged over 70 compared to younger adults aged 18 to 34 years (aRR:1·2; 95% CI:1.1,1·5). Those with lowest household income were three times less likely to be able to work from home (aRR:0.33; 95% CI:0.24 to 0.45) and less likely to be able to self-isolate (aRR:0.92; 95% CI:0.88 to 0.96). Ability to self-isolate was also lower in black and minority ethnic groups (aRR:0.89; 95% CI:0.79 to 1.0). Willingness to self-isolate was high across all respondents.

Conclusions Ability to adopt and comply with certain non-pharmaceutical interventions (NPIs) is lower in the most economically disadvantaged in society. Governments must implement appropriate social and economic policies to mitigate this. By incorporating these differences in NPIs among socio-economic subpopulations into mathematical models of COVID-19 transmission dynamics, our modelling of epidemic outcomes and response to COVID-19 can be improved.

Keywords: COVID-19, novel coronavirus, epidemic, pandemic, behavioural response, risk perceptions

Article Summary

Strengths and limitations of this study

- Nationally representative sample of the UK adult population
- Quick data collection during a rapidly evolving public health emergency
- Timeliness in relation to changing government response and recommendations
- The online approach excludes those without internet access
- Collecting self-report data are generally subject to limitations including honesty, introspective ability and interpretation of the questions.

Introduction

On 31 December 2019, Chinese authorities notified the World Health Organisation (WHO) of an outbreak of pneumonia in Wuhan City, which was later classified as a new disease: COVID-19 [1]. Following identification of cases in countries outside China, on 30 January 2020, WHO declared the outbreak of COVID-19 a "Public Health Emergency of International Concern"[1]. In the UK, the first cases of COVID-19 were diagnosed at the end of January 2020, and community transmission was reported a few weeks later [2,3]. Government measures to control the epidemic were first announced on 22 January 2020 and included travel advice, information for those returning from affected countries, testing of suspected cases, isolation and contact tracing. This was followed in early February by a public health information campaign advising people to adopt hygiene measures to protect themselves and others, including more frequent handwashing with soap and water, using hand sanitiser if soap and water are not available, and covering mouth and nose with a tissue or sleeve when coughing or sneezing [4]. Then, on 3 March 2020, the UK Government published its action plan setting out the UK-wide response to the novel coronavirus. The UK Government's response outlined measures in four key areas: containing the outbreak, delaying its spread, mitigating the impact, and research to improve diagnostics and treatment [5].

On March 16 2020, five days after the WHO declared the outbreak of COVID-19 a pandemic, the UK Prime Minister announced a shift to the delay phase of the UK response with measures aimed at suppressing the spread of the infection in the population through non-pharmaceutical interventions (NPIs), including social distancing of the whole population, isolation of cases for 7 days and quarantine of their household members for 14 days [6]. The public was advised to stop non-essential contact with others and all unnecessary travel: including working from home where possible and avoiding pubs, theatres, restaurants and other social venues [6]. This shift in response was prompted by a mathematical modelling study which showed that a combination of social distancing of the entire population, home isolation of cases and household quarantine of their family members (and possible school and university closure) was required to suppress transmission to a level that would enable the NHS to cope with the surge in cases requiring hospital admission and ventilation [7].

The effect of NPIs to reduce transmission rates is dependent on compliance with public health advice on social distancing. In the initial stages of the UK epidemic, this advice was voluntary, and not enforced by the government. This was criticised due to concern that

measures may not have the desired impact if a significant proportion of the population were unable or unwilling to comply.

Protective behaviours are not uniformly adopted throughout a population during an epidemic. Evidence from influenza outbreaks suggests that females are more likely to adopt NPIs than males [8,9]. In the UK, during the H1N1 pandemic, non-white ethnic groups were more likely to adopt hygiene and social distancing behaviours compared to white [10,11]. Employment status has also been associated with NPI adoption [12,13]. Evidence from Australia during the H1N1 pandemic found those who were self-employed and who were unable to work from home were most likely to report intentions to not comply with preventative measures [13], suggesting that without support, it may be challenging for individuals who are unable to work from home to comply with certain public health recommendations. During the current COVID-19 pandemic, public risk perceptions and knowledge have been explored in various countries [14-20]**.** However, only a few have identified the factors associated with greater adoption of preventative measures, or how these associations vary by context. In Hong Kong, both greater understanding of COVID-19 and increased anxiety were associated with greater adoption of social distancing behaviours [18].

As such, this study aimed to assess reported behaviour and intention to comply with the NPIs, as recommended by the UK Government at the time of the survey. Preliminary findings were shared with the Scientific Advisory Group for Emergencies (SAGE), which advises the UK Government's response to COVID-19 [21].

Methods

Study design and sample

A cross-sectional survey of a nationally representative sample of the UK adult (aged 18 years and over) population was conducted between March 17 and 18 2020, which followed the UK Government's 16 March announcement to increase social distancing measures by advising the public to stop non-essential contact with others and all unnecessary travel [6].

The online survey was administered by YouGov, a market research company, to members of its UK panel of 800,000+ individuals [22]. This panel includes individuals who have specifically opted in to participate in online research activities. YouGov actively recruits hard-

to-reach individuals to this panel (such as younger people and those from ethnic minorities) via a network of partners with specific experience in recruiting these audiences for online activities or with access to a wide range of online sources that cater to these groups.

A sample of 2,108 adults was achieved through non-probabilistic quota sampling [22]. Emails were sent to 2,500 panellists from the base sample, randomly selecting panellists with particular age, sex, ethnicity and UK geographical region of residence characteristics to achieve quotas that matched the proportions of people with those characteristics in the UK 2011 census data [23]. The response rate was 84.3% (2,108/2,500). No incentive was given to participate in the survey.

Survey Instrument

The questionnaire was adapted from a survey used in a similar study conducted in Hong Kong [24]. The questionnaire had four components: (1) socio-demographic characteristics, (2) risk perceptions towards COVID-19, (3) preventive behaviours, and (4) ability and willingness to self-isolate.

Socio-demographic characteristics consisted of sex, age, ethnicity, marital status, caring responsibilities, UK area of residence, and socio-economic status (SES). SES was assessed using five indicators: education level, employment status, household income, savings, and household tenure.

Risk perceptions towards COVID-19 were measured by perceived susceptibility and perceived severity. Susceptibility was measured by asking respondents about perceived likelihood of being infected with COVID-19 under the UK Government's current preventive measures. Severity was measured by asking respondents about perceived seriousness of symptoms if they were infected with COVID-19.

Preventive behaviours included information on perceived effectiveness and actual adoption of preventive behaviours (to protect oneself and others), to prevent both contracting COVID-19 and onward transmission, and were collected under three categories: (1) hygiene practices (wearing a face mask, washing hands more frequently with soap and water, using hand sanitiser more regularly, disinfecting the home, covering nose and mouth when sneezing or coughing) (2) travel avoidance (travel to affected countries and travel to areas

inside and outside the UK, regardless of whether they were affected) (3) social distancing (avoiding public transport, social events, going out in general, going to hospital or other healthcare settings, crowded places, and contact with people who have a fever or respiratory symptoms).

Willingness to self-isolate was measured by asking respondents whether, if advised by a healthcare professional, they would be willing to self-isolate. Similarly, a*bility to self-isolate* was measured by asking respondents whether, if advised by a healthcare professional, they would be able to self-isolate.

At the time the survey was conducted, Public Health England's operational definition of 'self-isolation' was "*if you have symptoms of coronavirus infection (COVID-19), however mild, do not leave your home (even to buy food or essentials) or have any visitors for 7 days from when your symptoms started. This includes not going to work, school or other public places, and avoiding public transport or taxis. Self-isolation is the same as voluntary quarantine.*"[25]

We worked with YouGov to optimise question clarity and ease of understanding for the UK population.

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: http://www.imperial.ac.uk/medicine/departments/school-public-health/infectious-disease-epidemiology/mrc-global-infectious-disease-analysis/covid-19/covid-19-scientific-resources/

Data Collection

Data were collected between 1630 GMT on 17 March 2020 and 1030 GMT on 18 March 2020. Participants identified for the sample were sent an email with a survey link. YouGov returned the anonymised data set to the Imperial College London research team for analysis.

Data Analysis

Analyses were conducted in Stata 15 and SPSS version 25.

Descriptive statistics for all variables present the number of respondents and the weighted percentages. Percentages were weighted for age, sex, region and ethnicity to account for

variation in response rates, so as to be representative of the population (18+ years) of the UK. Details of the weighting approach used and the sample population profile are in the Supplement, S1.

For analysis, age, collected as discrete count in years, was collapsed into four age bands routinely used in the UK to report COVID-19 related data. Ethnicity data were collected using the 18 response categories used in the UK 2011 Census [23] but were collapsed into two categories (white / Black, Asian and minority ethnic (BAME)) because of small numbers of respondents in BAME groups.

Robust Poisson regression, by estimating relative risk (RR), was used to identify sociodemographic variation in: (1) adoption of social-distancing measures, (2) ability to work from home, and (3) ability and (4) willingness to self-isolate. Adoption of social distancing measures was proxied by respondents reporting to have avoided crowded places and social events to protect themselves or others from COVID-19. For our outcomes of interest, an RR>1 indicated that the group was more likely to (1) adopt social distancing measures, (2) be able to work from home, and (3) be able and (4) willing to self-isolate relative to the reference group for that independent variable.

Age and sex were retained in all the regression models as they are considered important confounders. Including as many explanatory variables as possible can dilute true associations and lead to large standard errors with wide and imprecise confidence intervals, or, conversely, identify spurious associations [26]. The conventional technique is to first run the univariate analyses and then use only those variables which meet a pre-set cut-off for significance to run a multivariable model [26]. This cut-off is often more liberal than the conventional cut-off for significance (e.g., $P < 0.20$, instead of the usual $P < 0.05$) since its purpose is to identify potential predictor variables rather than to test a hypothesis [26]. Therefore, only variables that appeared to be associated ($p<0{\cdot}20$) in the unadjusted analyses were considered in the adjusted analyses. Adjusted relative risk (aRR) and 95% confidence intervals (CI) were estimated. Associations with a p-value $<0{\cdot}05$ in the adjusted analyses were considered to be statistically significant. We did not adjust our p-values for multiple comparisons to reduce type I errors for null associations because this increases type II errors for those associations that are not null [27,28]. Not adjusting for multiple comparisons in the context of this study is preferable because it will result in less errors of interpretation as the

data under examination are not random numbers but actual observations on people. Furthermore, in the context of a global pandemic caused by an emerging infectious disease it may be better to explore leads that may turn out to be wrong than risk missing possibly important findings that could provide insights for control of the virus.

We tested for collinearity between education level, employment status, household income, savings, and household tenure. For these categorical variables, collinearity was measured by examining bivariate relationships using Pearson's Chi-squared tests. Where collinearity was detected we ran separate adjusted regression analyses for those variables, using only other explanatory variables in those models that were not strongly correlated.

Patient and Public Involvement

Prior to conducting the study, we distributed an online feedback form to communities across the UK using local networks of public partners and contacts, Twitter and via VOICE-global.org, an online platform for public involvement in research established by Newcastle University. We received 420 responses, including 328 from members of the public. The experiences and feedback shared guided our study design and scope, including the phrasing of the survey tool's closed-ended questions and the refinement of pre-populated answer choices.

Study results will be shared with the public both by posting on the VOICE-global.org news page, on the research team's website, and through direct mail with those who consented to be contacted about our research and involvement activity.

Ethical approval

The Imperial College London Research Ethics Committee approved the study (Ref 20IC5861). Informed consent was obtained from those who chose to complete the survey after having read introductory information on its content and purpose.

Results

The overall sample is described in Table 1. There was lower response among people from minority ethnic groups and older age groups compared to the UK population profile (Supplement, S1 for full details of the sample profile compared to UK population profile). In summary, of the 2,108 respondents, 11·1% were 18 to 24 years old, and 13·5% were 70

years or older. The majority of respondents were white (93·9%). In total, 43·4% were in full-time work and 14·1% were in part-time work.

Overall, 77·4% (1,640/2,108) of respondents reported being worried about the COVID-19 outbreak in the UK. None of the 2,108 respondents had previously tested positive for COVID-19, and 47·5% (979/2,108) believed that it was likely they would be infected at some point in the future under the UK Government's preventive measures. If infected, just over half (56·9%) of respondents would expect to be moderately severely affected (e.g. may need self-care and rest in bed) (Table 1).

Accordingly, 94·2% of adults reported taking at least one preventive measure (to protect oneself and others) against COVID-19 infection: 85·8% washed their hands with soap more frequently; 56·5% avoided crowded areas; 54·5% avoided social events and 39·2% avoided public transport (Figure 1). Most reported that their behaviour change was in response to government guidance (71·3%). Preventive measures perceived to be most effective were washing hands more frequently with soap and water (92·5%), avoiding contact with people who have a fever or respiratory symptoms (91·4%), and covering nose and mouth when sneezing or coughing (90·0%) (Figure 1). Perceived effectiveness of preventive measures was higher than actual adoption for all measures. This was particularly marked for social distancing measures (Figure 1).

Adoption of social-distancing measures

Overall, 45·2% of respondents reported adopting social distancing measures (avoiding crowded places and avoiding social events) to protect themselves or others from COVID-19.

Table 2 shows the regression analysis results for adoption of social-distancing measures. Being 70 years or older (64·2% vs. 38·4%; aRR:1·2; 95% CI:1.1,1·5) was positively associated with greater adoption compared to younger adults aged 18 to 34 years. Compared with those who were married, in a civil partnership, or living as married (48·4%), respondents who were separated, divorced, or widowed (44·1%; aRR:0·75; 95% CI:0·64,0·87) or never married (38·4%; aRR:0·74; 0·63,0·88) were less likely to have adopted social distancing measures to prevent transmission of COVID-19. Respondents with £100 savings or less were a fifth less likely to have adopted social distancing measures compared to those with £25,000 or more in savings (43.5% vs. 48.4%; aRR:0·83; 95% CI:0·73,0·95) (Table 2).

Table 1. Demographics, socio-economic characteristics and COVID-19 risk perceptions, N=2,108

Characteristic	No.	Weighted %
Demographic and socio-economic		
Age (years)		
18-24	218	11·1
25-34	294	14·4
35-44	396	19·3
45-54	355	17·5
55-69	519	24·2
70 or above	326	13·5
Sex		
Male	987	48·0
Female	1094	50·7
Prefer not to say	27	1·3
Ethnicity		
White	1985	93·9
Asian/Asian British	48	2·4
Black / African / Caribbean / Black British	20	1·0
Other ethnic group, including mixed/multiple ethnic groups	39	1·9
Prefer not to say	16	0·77
Marital status		
Married, civil partnership, or living as married	1283	60·3
Separated, divorced, or widowed	270	12·2
Never married	545	27·1
Prefer not to say	10	0·45
Area of residence		
London	239	13·1
North	522	23·3
Midlands	531	25·2
South	485	22·5
N. Ireland, Scotland, Wales	331	15·9
Education		
No formal qualification	121	5·5
Secondary-level qualification	859	42·1
Post-secondary-level, below bachelor	148	6·9
Bachelor-level or above	664	30·8
Other technical, professional or higher qualification	245	11·2
Don't Know	32	1·6
Prefer not to say	39	2·0
Employment status		
Working full time	889	43·4
Working part time	292	14·1
Full time student	112	5·6
Retired	553	23·6
Unemployed or not working	207	10·5
Other	55	2·8
Household income		
<£20,000	440	20·7
£20,000 to £29,999	355	16·8
£30,000-£49,999	472	22·4
£50,000 and over	429	20·6
Don't know	103	5·1

Prefer not to say	309	14·4
Savings		
Less than £100	278	13·6
£100 to £999	242	11·8
£1,000 to £4,999	305	14·5
£5,000 to £24,999	359	16·6
£25,000 or more	359	16·6
Prefer not to say	565	26·9
Housing tenure		
Own – outright	681	30·4
Own – mortgage/shared ownership	639	30·8
Rent – private landlord	319	15·6
Rent – local authority/housing association	219	10·7
Live with parents, family or friends	215	10·7
Other	35	1·8
COVID-19 risk perceptions		
Level of worry about the current COVID-19 outbreak in the UK		
Worried	1640	77·4
Not worried	454	21·9
Don't know	14	0·74
Perceived susceptibility[a]		
Likely	979	47·5
Neither likely or unlikely	547	26·2
Unlikely	337	15·9
Don't know	220	10·5
Perceived severity[b]		
I would expect it to be life-threatening	103	4·7
I would expect it to be severe (e.g. may need care and treatment in hospital)	306	14·2
I would expect it to be moderate (e.g. may need self-care and rest in bed)	1180	56·9
I would expect it to be mild (e.g. can go about daily tasks normally)	351	17·2
I would expect to have no symptoms	33	1·7
Don't know	110	5·3

[a]Under the UK government's current preventive measures (at the time of the study), how likely or unlikely do you think it is you will be infected with the coronavirus (COVID-19) at any point in the future?

[b]Please imagine you were infected with coronavirus (i.e. COVID-19), which of the following do you think would best apply?

Figure 1. Perceived effectiveness and actual adoption of preventative measures to prevent transmission of COVID-19; N=2,108

Table 2. Social distancing behaviour and ability to work from home by a range of sociodemographic factors, N=2,108

	Social distancing measures being taken yes vs no [a]				Able to work from home yes vs no (N=1,149) [d]			
	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Social distancing								
Yes	969	45·2						
No	1,139	54·8						
Ability to work from home								
Yes					540	44·3		
No					609	53·0		
Don't Know					32	2·7		
Age								
18-34	202	38·4	Ref	Ref[b]	154	48·0	Ref	Ref[e]
35-49	229	40·8	1·1 (0·91-1·2)	0.86 (0·74-1·0)	220	48·0	1·0 (0·86-1·2)	0·98 (0·94-1·3)
50-69	329	46·4	**1·2 (1·1-1·4)****	0.81 (0·73-1·0)	151	39·9	**0·83 (0·70-0·99)***	0·90 (0·81-1·1)
70 or older	209	64·2	**1·7 (1·5-1·9)*****	**1·2 (1·1-1·5)***	15	53·9	1·1 (0·78-1·6)	1·1 (0·96-1·7)
Sex								
Male	436)	42·9	Ref	Ref[b]	280	46·1	Ref	Ref[e]
Female	519	47·4	**1·1 (1·0-1·2)***	1·0 (0·88-1·2)	254	44·8	0·97 (0·85-1·1)	0·98 (0·86-1·2)
Ethnicity								
White	919	45·5	Ref	-	506	45·1	Ref	Ref[e]
Black, Asian and minority ethnic	45	42·1	0·92 (0·73-1·2)		31	54·2	1·2 (0·94-1·5)	1.0 (0·98-1·1)
Marital status								
Married, civil partnership, or living as married	628	48·4	Ref	Ref[b]	366	47·2	Ref	-
Separated, divorced, or widowed	121	44·1	0·91 (0·79-1·1)	**0·75 (0·64-0·87)*****	43	39·5	0·84 (0·65-1·1)	
Never married	214	38·4	**0·79 (0·70-0·90)*****	**0·74 (0·63-0·88)****	128	43·5	0·92 (0·79-1·1)	
Area of residence								
London	111	45·2	Ref	-	76	54·0	Ref	Ref[e]
North of England	220	41·6	0·92 (0·77-1·1)		129	44·7	0·83(0·67-1·0)	1·0 (0·76-1·2)
Midlands and East of England	249	46·0	1·0 (0·86-1·2)		123	44·4	0·82 (0·67-1·0)	1.0 (0·75-1·1)
South of England	221	45·0	0·99 (0·84-1·2)		151	49·0	0·91 (0·75-1·1)	1·0 (0·88-1·4)

N. Ireland, Scotland, Wales	168	49·9	1·1 (0·92-1·3)		61	35·2	**0·65 (0·50-0·84)****	0·76 (0·59-1·0)
Education								
Degree or above	321	48·0	Ref	-	289	62·6	Ref	Ref[f]
Post-secondary	186	46·7	0·97 (0·85-1·1)		105	47·7	**0·76 (0·65-0·89)****	**0·68 (0·59-0·79)*****
Secondary or below	436	43·7	0·91 (0·82-1·0)		137	29·4	**0·47 (0·40-0·55)*****	**0·45 (0·39-0·53)*****
Employment status								
Working full time	344	38·6	Ref	Ref[b]	439	48·9	Ref	Ref[f]
Working part time	136	46·8	**1·2 (1·0-1·4)***	1·0 (0·86-1·2)	101	35·0	**0·71 (0·60-0·85)*****	0·93 (0·84-1·2)
Full time student	43	36·3	0·94 (0·73-1·2)	1·0 (0·71-1·5)	N/A	N/A	N/A	N/A
Retired	331	59·7	**1·5 (1·4-1·7)*****	1·1 (0·90-1·3)	N/A	N/A	N/A	N/A
Unemployed / Not working	95	45·4	1·2 (0·99-1·4)	1·1 (0·90-1·4)	N/A	N/A	N/A	N/A
Household income								
£50,000 and over	178	41·0	Ref	Ref[c]	241	67·3	Ref	Ref[g]
£30,000 to £49,999	211	43·8	1·1 (0·92-1·2)	1·0 (0·87-1·2)	131	42·6	**0·63 (0·54-0·74)*****	**0·55 (0·47-0·63)*****
£20,000 to £29,999	173	48·5	**1·2 (1·0-1·4)***	1·1 (0·89-1·3)	64	30·7	**0·46 (0·37-0·57)*****	**0·41 (0·33-0·52)*****
<£20,000	218	49·0	**1·2 (1·0-1·4)***	1·0 (0·87-1·2)	31	22·7	**0·34 (0·24-0·47)*****	**0·33 (0·24-0·45)*****
Savings								
£25,000 or more	177	48·4	Ref	Ref[c]	100	59·9	Ref	Ref[g]
£5,000 to £24,999	177	48·7	1·0 (0·86-1·2)	1·1 (0·93-1·3)	131	57·6	0·96 (0·81-1·1)	0·90 (0·76-1·1)
£1,000 to £4,999	126	40·7	0·84 (0·71-1·0)	**0.76 (0·67-0.87)*****	89	43·7	**0·73 (0·59-0·90)****	**0·67 (0·54-0·83)*****
£100 to £999	91	37·4	**0·77 (0·63-0·94)***	**0·73 (0·61-0.87)*****	67	40·1	**0·67 (0·53-0·84)****	**0·64 (0·50-0·81)*****
Less than £100	122	43·5	0·90 (0·76-1·1)	**0.83 (0·73-0.95)*****	54	33·1	**0·55 (0·43-0·71)*****	**0·51 (0·39-0·67)*****
Housing tenure								
Own outright	377	55·0	Ref	Ref[c]	93	41·0	Ref	Ref[g]
Own with mortgage/shared ownership	261	40·8	**0·74 (0·66-0·83)*****	0·95 (0·82-1·1)	293	55·0	**1·3 (1·1- 1.6)****	1·0 (0·73-1.5)
Rented from private landlord	145	45·0	**0·82 (0·71-0·94)****	1·1 (0·90-1·3)	85	39·8	0·97 (0·77-1·2)	0·92 (0·83-1.1)
Rented from local authority/housing association	94	42·2	**0·77 (0·65-0·91)****	0·90 (0·75-1·1)	16	18·2	**0·44 (0·27-0·72)****	**0·45 (0·28-0·73)****
Live with parents, family, or friends	78	35·4	**0·64 (0·53-0·78)*****	0·93 (0·70-1·2)	46	43·6	1·1 (0·81-1·4)	0·79 (0·65-1·0)

[a]Those that report avoiding crowded areas AND social events; [b]Mutually adjusted for age, sex, marital status, employment status, household income, savings and housing tenure; [c]Adjusted for age, sex, marital status and employment status. [d]Excluding those who responded "Don't know"; [e]Mutually adjusted for age, sex, ethnicity, UK area of residence, education, employment status, household income, savings and housing tenure; [f]Adjusted for age, sex, ethnicity, UK area of residence and housing tenure; [g]Adjusted for age, sex, ethnicity and UK area of residence. *p<·05, **p<·01, ***p<·001

Ability to work from home

Overall, 44·3% of respondents reported being able to work from home (i.e. permitted by their employer and have the necessary equipment to do their job from home).

Respondents who held post-secondary but below degree-level (47·7%; aRR:0·68; 95% CI:0·59,0·79) and secondary or below level (29·4%; aRR:0·45; 95% CI:0·39,0·53) education qualifications were less likely to be able to work from home compared with those educated to degree level (62·6%) (Table 2). As with educational level, there was a household income and savings gradient with ability to work from home. Those with the lowest household income (<£20,000) were three times less likely to be able to work from home compared to those with household incomes of £50,000 and above (22·7% vs. 67·3%; aRR:0·33; 95% CI:0·24,0·45). Respondents with £100 savings or less were half as likely to be able to work from home compared to those with £25,000 or more in savings (33·1% vs. 59·9%; aRR:0·51; 95% CI:0·39,0·67) (Table 2). Compared with those who owned their home outright, those renting accommodation from a local authority or housing association were less likely to be able to work from home (18·2% vs. 41·0%; aRR:0·45; 95% CI:0·28,0·73).

Willingness and ability to self-isolate

Overall, perceived ability (87·0%) and willingness (87·6%) to self-isolate for 7 days if asked by a healthcare professional were high.

In terms of socio-demographic associations, there was no effect of sex on perceived ability to self-isolate (Table 3). However, women were somewhat more willing to do so than men (94·9% vs. 91·8%; aRR:1·1; 95% CI:1·0,1·2). Respondents from ethnic minority backgrounds perceived themselves to be less able to self-isolate than respondents from white backgrounds (84·8% vs. 92·1%, aRR:0.89; 95% CI:0.79 to 1.0), although they were equally willing to do so (Table 3).

Some indicators of socioeconomic status were significantly associated with perceived ability and willingness to self-isolate. Respondents who held post-secondary but below degree-level education qualifications were less willing to self-isolate (90·9% vs. 94·9% aRR:0·95; 95% CI:0·92,0·99) than respondents educated to degree level (Table 3). Those with household incomes below £20,000 were less likely to be able to self-isolate compared with those on

Table 3. Ability and willingness to self-isolate by sociodemographic factors

	Able to self-isolate yes vs no (N=2,002)[a]				Willing to self-isolate yes vs no (N=1,978) [a]			
	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)	N	Weighted %	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Self-isolation ability/willingness								
Yes, I would	1,834	87·0			1,847	87·6		
No, I wouldn't	168	8·0			131	6·2		
Don't know	106	5·0			130	6·2		
Age								
18-34	466	90·8	Ref	Ref[b]	457	91·6	Ref	Ref[d]
35-49	494	90·0	0.99 (0·95-1·1)	1·0 (0·96-1.1)	508	94·2	1·0 (0·99-1.1)	1·0 (0·98-1.1)
50-69	614	92·2	1·0 (0·98-1·1)	1·0 (0·97-1·1)	627	93·6	1·0 (0·99-1·1)	1·0 (0·96-1.1)
70 or older	262	94·9	**1·1 (1·0-1.2)***	1·0 (0·96-1.1)	255	94·4	1·0 (0·99-1.1)	1·0 (0·96-1.1)
Sex								
Male	878	90·7	Ref	Ref[b]	878	91·8	Ref	Ref[d]
Female	957	92·5	1·0 (0·99-1·1)	1·0 (0·98-1·1)	969	94·9	**1·1 (1·0-1.2)****	**1·1 (1·0-1.2)***
Ethnicity								
White	1,737	92·1	Ref	Ref[b]	1,751	93·7	Ref	Ref[d]
Black, Asian and minority ethnic	89	84·8	**0·92 (0·84-0·99)***	**0·89 (0·79-1·0)***	86	87·8	0·94 (0·87-1.0)	0·96 (0·87-1·1)
Marital status								
Married, civil partnership, or living as married	1,128	92·3	Ref	-	1,143	94·5	Ref	Ref[d]
Separated, divorced, or widowed	215	90·7	0·98 (0·94-1·2)		219	92·8	0·98 (0·95-1·1)	0·98 (0·93-1·1)
Never married	482	90·3	0·97 (0·95-1·1)		477	91·0	**0·96 (0·93-0·99)***	0·99 (0·95-1·1)
Area of residence								
London	241	91·6	Ref	-	243	92·7	Ref	-
North of England	427	91·2	0.99 (0·95-1·1)		430	93·7	1·0 (0·97-1·1)	
Midlands and East of England	465	93·0	1·0 (0·97-1.2)		465	93·9	1·0 (0·97-1·1)	
South of England	408	89·5	0·98 (0·93-1·1)		411	92·2	0·99 (0·95-1·0)	
N. Ireland, Scotland, Wales	294	92·7	1·0 (0·96-1·2)		297	94·3	1·0 (0·97-1.1)	
Education								
Degree or above	584	93·1	Ref	-	591	94·9	Ref	Ref[e]

Post-secondary	332	90·2	0·97 (0·93-1·1)		329	90·9	**0·96 (0·92-0·99)***	**0·95 (0·92-0·99)***
Secondary or below	863	91·3	0·98 (0·95-1·1)		873	93·6	0·98 (0·96-1·0)	1·0 (0·97-1·0)
Employment status								
Working full time	799	91·4	Ref	Ref[b]	804	93·6	Ref	-
Working part time	255	90·4	0·99 (0·95-1·0)	0·98 (0·93-1·0)	263	92·9	0·99 (0·96-1·0)	
Full time student	105	93·8	1·0 (0·97-1.1)	1·0 (0·94-1.1)	97	89·0	0·95 (0·88-1·0)	
Retired	450	95·1	**1·1 (1·0-1.2)****	1·0 (0·96-1·1)	444	94·7	1·0 (0·98- 1.1)	
Unemployed or not working	185	89·8	0·98 (0·93-1·0)	1·0 (0·93-1·1)	191	94·1	1·0 (0·96-1.1)	
Household income								
£50,000 and over	405	95·5	Ref	Ref[c]	393	94·7	Ref	-
£30,000 to £49,999	417	90·7	**0·95 (0·92-0·98)****	**0·95 (0·92-0·98)****	424	93·6	0·99 (0·95-1·2)	
£20,000 to £29,999	311	92·6	0·97 (0·94-1·1)	0·96 (0·93-1·0)	308	91·9	0·97 (0·93-1·1)	
<£20,000	363	88·3	**0·93 (0·89-0·96)*****	**0·92 (0·88-0·96)*****	383	93·0	0·98 (0·95-1·1)	
Savings								
£25,000 or more	329	95·6	Ref	Ref[c]	318	94·1	Ref	Ref[f]
£5,000 to £24,999	319	95·2	1.0 (0·96-1·1)	1·0 (0·97-1.1)	317	95·8	1·0 (0·98-1.1)	1·0 (0·98-1·1)
£1,000 to £4,999	274	92·3	0·96 (0·93-1·1)	0·99 (0·95-1·0)	272	92·8	0·98 (0·94-1·1)	0·99 (0·96-1·0)
£100 to £999	217	90·0	**0·94 (0·90-0·98)***	0·97 (0·92-1·1)	221	94·8	1·0 (0·97-1.1)	1·0 (0·96-1.1)
Less than £100	232	84·4	**0·88 (0·83-0·93)*****	**0·90 (0·85-0·96)****	250	90·9	0·96 (0·92-1·0)	0·96 (0·91-1·1)
Housing tenure		93·8						
Own outright	576	92·1	Ref	Ref[c]	575	95·0	Ref	Ref[g]
Own with mortgage/shared ownership	571	89·1	0·98 (0·95-1·0)	1.0 (0·96-1·1)	584	95·0	1.0 (0·97-1·0)	1.0 (0·97-1·1)
Rented from private landlord	277		**0·95 (0·91-0·99)***	0·97 (0·92-1·0)	297	94·3	0·99 (0·96-1·0)	1.0 (0·95-1·1)
Rented from local authority/housing association	188	87·9 92·9	**0·94 (0·89-0·99)***	0·97 (0·91-1·0)	188	90·0	**0·94 (0·90-0·99)***	**0·94 (0·89-0·99)****
Live with parents, family, or friends	197		0·99 (0·95-1·1)	1·0 (0·97-1.1)	178	88·1	**0·92 (0·88-0·98)***	0·95 (0·89-1·0)

[a]Excluding those who responded "Don't know"; [b]Mutually adjusted for age, gender, ethnicity, employment status, household income, savings, and housing tenure; [c]Adjusted for age, gender, ethnicity, and employment status; [d]Mutually adjusted for age, gender, ethnicity, marital status, education, savings, and housing tenure; [e]Adjusted for age, gender, ethnicity, marital status, and housing tenure; [f]Adjusted for age, gender, ethnicity, and marital status; [g]Adjusted for age, gender, ethnicity, marital status, and education; *p<·05, **p<·01, ***p<·001

household incomes of £50,000 and above (88·3% vs. 95·5%; aRR:0·92; 95% CI:0·88,0·96). Similarly, respondents with less than £100 in savings were less likely to be able to self-isolate compared with those with savings of £25,000 or more (84·8% vs. 95·6%; aRR:0·90; 95% CI:0·85,0·96). There was no effect on willingness to self-isolate by household income or amount of savings (Table 3).

Those in accommodation rented from a private landlord, local authority, or housing association were less likely to report being able to self-isolate, although this association was no longer significant when other sociodemographic factors were adjusted for. In terms of willingness to self-isolate, respondents renting accommodation from a local authority or housing association were less likely to be willing to self-isolate compared with those who owned their home outright (aRR:0·94; 95% CI:0·89,0·99) (Table 3).

Discussion

This study reports on the perceptions and behaviour of the UK adult population in the two days following the UK Government's introduction of recommendations on social distancing on March 16 2020 [6]. We found high levels of self-reported behaviour change. Notably, the most-adopted measures, washing hands more frequently with soap and water, using hand sanitiser, and covering nose and mouth when sneezing or coughing, prominently featured in national public health campaigns from relatively early on in the epidemic [4], and mirrors results seen in previous pandemics [29]. However, there were marked differences between the perceived effectiveness and adoption of NPIs. This suggests that lack of knowledge on what measures are effective against COVID-19 is not a key driver of compliance in the UK population. In contrast, a similar study conducted in Hong Kong showed comparatively high perceived effectiveness and adoption of preventive measures [24].

Our results highlighted significant differences across demographic and socioeconomic strata for social distancing behaviour, ability to work from home, and the ability and willingness of people to self-isolate. There was a strong association between socioeconomic deprivation and ability to adopt NPIs. Although willingness to self-isolate was high overall, those from more disadvantaged backgrounds were less likely to be able to work from home or self-isolate if needed, suggesting the existence of structural barriers to adopting preventive behaviours in these groups. Specifically, our study found that those with less savings were the group least likely to adopt NPIs overall. As such, the barriers for this group appear the

greatest. This is not surprising, as these individuals are likely to have less cushioning to withstand financial losses as a result of any NPIs that have a direct or indirect impact on employment or earnings.

The strength of this study is in the representative sample of the UK adult population, the ability to achieve our sample size quickly, and the timeliness in relation to changing government recommendations. However, social distancing measures were only brought in two days before the survey. Therefore, there may have not been enough time for people to fully implement these measures prior to their participation in the study. But many employers had already begun allowing staff to work from home in the week prior to the UK Government's announcement, and ability and willingness to self-isolate do not measure behaviour change directly but intent. So, we believe our study does indeed measure attitudes and behaviours based on the most recent advice at the time of the survey. Social desirability bias is also possible given that participants were asked whether they were complying with government restrictions. However, this is less of an issue with online surveys where respondents are assured anonymity and answer questions in the privacy of their own home without any live human interaction. In addition, our sampling approach is prone to selection bias, for example by excluding participants without internet access and non-English speakers, and sampling from a panel of individuals who have specifically opted in to participate in online research activities. As in almost all population surveys, our study had unequal participation, with lower response among people from minority ethnic groups and older age groups. We re-weighted the sample to account for such differential response, although this may not have overcome unknown participation biases. Furthermore, surveys collecting self-report data are generally subject to limitations including honesty, introspective ability, and interpretation of the questions. The survey tool consisted of predominantly closed-ended questions. Thus, we were unable to explore responses in more depth.

Our findings highlight the stark choices faced by those in lower socioeconomic groups and suggest that unless the government intervenes to support these individuals, the impact of this epidemic will likely be felt unequally in our society. Not only this, but if a large proportion of the population continues to work while unwell, low compliance will render the various forms of social distancing less effective, as low-income workers are forced to choose between financial and physical health. Indeed, this behaviour has already been observed in

the workplace in previous pandemics: workers without access to paid sick leave were more likely to work while unwell than those with paid sick leave [30]. A study in China after the H7N9 epidemic found that only 7% of people reported willingness to self-quarantine [31]. Also, during the Middle East Respiratory Syndrome (MERS) outbreak in South Korea in 2015, there was heterogeneous uptake of preventive interventions [32].

In the absence of a vaccine and treatments over the short-term, high compliance with social distancing, self-isolation and household quarantine is paramount to reduce transmission and the impact of COVID-19. NPI compliance, risk perception and behaviour are not consistent across cultures, social status or time. Indeed, previous studies have shown that perceptions and behaviours often change over time [29]. Therefore, current modelling projections of the impact of NPIs on morbidity and mortality are always provisional [7]. Future COVID-19 models should explore the variation captured in this and previous studies to better estimate the impact of differential uptake of NPIs in the UK and beyond. It is also important to monitor behaviour throughout the epidemic to know when to implement further public health messaging, and when further or alternative government actions might be required, to mitigate falling compliance.

Conclusions and policy implications

Our findings highlight that those most economically disadvantaged in society are less able to comply with certain NPIs, likely in part due to their financial situation. Whilst one approach may be to better tailor public health messaging to this subpopulation, this must be done alongside considered fiscal and monetary policy to mitigate the financial costs of following government public health advice. Therefore, it is imperative that the UK Government, and governments around the world, quickly develop and implement policies to support the most vulnerable, in a bid to minimise the long-term social and economic harm caused by COVID-19. Government policy should recognise the disparity in impact across socioeconomic groups, particularly across the labour market, and should aim to support workers equitably across the income spectrum. This would likely help increase compliance across the population to the levels required to suppress transmission and thereby reduce the strain on national health services, both in the UK and abroad. Although the UK Government has since announced a range of measures to support public services, individuals, and businesses, in part to facilitate compliance with current lockdown measures [33], it is uncertain how long

these protections will be in place for and whether they will continue once lockdown restrictions are lifted.

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Contributors

CJA, LB, RR, PP and HW designed the study. CJA, JWE and CV analysed the data and performed the statistical analyses. CJA, LB, RR, CV and HW drafted the initial manuscript. All authors reviewed the drafted manuscript for critical content and approved the final version. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. CJA and HW are the guarantors.

Declaration of interests

The authors declare that they have no know competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data sharing

The survey instrument is freely available to download from the School of Public Health, Imperial College London COVID-19 resources webpage: https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/news--wuhan-coronavirus/covid-19-resources/

The data used for the analyses are available from the corresponding author on request.

References

1. World_Health_Organisation. Rolling updates on coronavirus disease (COVID-19) 2020 [Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.

2. ECDC. Coronavirus disease 2019 (COVID-19) pandemic: increased transmission in the EU/EEA and the UK – seventh update Stockholm; 2020 25 March 2020

3. Public_Health_England. Weekly Coronavirus Disease 2019 (COVID-19) Surveillance Report: Summary of COVID-19 surveillance systems 2020 [Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/888254/COVID19_Epidemiological_Summary_w22_Final.pdf.

4. Russell P. New Coronavirus: UK Public Health Campaign Launched. Medscape. 2020.

5. Department_of_Health_and_Social_Care. Coronavirus (COVID-19) action plan 2020 [Available from: https://www.gov.uk/government/publications/coronavirus-action-plan.

6. UK_Government. PM statement on coronavirus: 16 March 2020 2020 [Available from: https://www.gov.uk/government/speeches/pm-statement-on-coronavirus-16-march-2020.

7. Ferguson NM, Laydon D, Nedjati-Gilani G, et al. Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand. 2020.

8. Cowling BJ, Ng DMW, Ip DKM, et al. Community psychological and behavioral responses through the first wave of the 2009 influenza A(H1N1) pandemic in Hong Kong. The Journal of Infectious Diseases. 2010;202(6):867-76.

9. Agüero F, Adell MN, Pérez Giménez A, López Medina MJ, Garcia Continente X. Adoption of preventive measures during and after the 2009 influenza A (H1N1) virus pandemic peak in Spain. Prev Med. 2011;53(3):203-6.

10. Rubin GJ, Amlôt R, Page L, Wessely S. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross sectional telephone survey. BMJ. 2009;339:b2651.

11. Rubin GJ, Potts HW, Michie S. The impact of communications about swine flu (influenza A H1N1v) on public responses to the outbreak: results from 36 national telephone surveys in the UK. Health technology assessment (Winchester, England). 2010;14(34):183-266.

12. Lau JTF, Griffiths S, Choi KC, Tsui HY. Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. BMC Infectious Diseases. 2010;10(1):139.

13. Eastwood K, Durrheim D, Francis JL, et al. Knowledge about pandemic influenza and compliance with containment measures among Australians. Bull World Health Organ. 2009;87(8):588-94.

14. Lohiniva AL, Sane J, Sibenberg K, Puumalainen T, Salminen M. Understanding coronavirus disease (COVID-19) risk perceptions among the public to enhance risk communication efforts: a practical approach for outbreaks, Finland, February 2020. Euro Surveill. 2020;25(13).(doi):10.2807/1560-7917.ES.2020.25.13.2000317.

15. Gesser-Edelsburg A, Cohen R, Hijazi R, Abed Elhadi Shahbari N. Analysis of Public Perception of the Israeli Government's Early Emergency Instructions Regarding COVID-19: Online Survey Study. J Med Internet Res. 2020;22(5):e19370. doi: 10.2196/.

16. Olapegba PO, Ayandele O. Survey data of COVID-19-related Knowledge, Risk Perceptions and Precautionary Behavior among Nigerians. Data Brief. 2020;8(105685):105685.

17. Motta Zanin G, Gentile E, Parisi A, Spasiano D. A Preliminary Evaluation of the Public Risk Perception Related to the COVID-19 Health Emergency in Italy. Int J Environ Res Public Health. 2020;17(9).(pii):ijerph17093024. doi: 10.3390/ijerph.

18. Kin On K, Kin Kit L, Henry Ho Hin C, et al. Community Responses during Early Phase of COVID-19 Epidemic, Hong Kong. Emerging Infectious Disease journal. 2020;26(7).

19. McFadden SM, Malik AA, Aguolu OG, Willebrand KS, Omer SB. Perceptions of the adult US population regarding the novel coronavirus outbreak. PLoS One. 2020;15(4):e0231808. doi: 10.1371/journal.pone.. eCollection 2020.

20. Husnayain A, Shim E, Fuad A, Su EC-Y. Understanding the Community Risk Perceptions of the COVID-19 Outbreak in South Korea: Infodemiology Study. J Med Internet Res. 2020;22(9):e19788.

21. Atchison CJ, Bowman L, Eaton JW, et al. Report 10: Public Response to UK Government Recommendations on COVID-19: Population Survey, 17-18 March 2020 2020.

22. YouGov. ESOMAR28: 28 questions to help online research buyers14 March 2020. Available from: http://doc.ukdataservice.ac.uk/doc/7647/mrdoc/pdf/7647_methodology_esomar_28.pdf.

23. Office_for_National_Statistics. UK 2011 census data [Available from: https://www.ons.gov.uk/census/2011census.

24. Kwok KO, Li KK, Chan HHH, et al. Community responses during the early phase of the COVID-19 epidemic in Hong Kong: risk perception, information exposure and preventive measures. medRxiv. 2020.

25. Fenton K, Pawson E, de Souza-Thomas L. Beyond the Data: Understanding the Impact of COVID-19 on BAME Communities. PHE. Online report. 2020 [Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/892376/COVID_stakeholder_engagement_synthesis_beyond_the_data.pdf.

26. Ranganathan P, Pramesh CS, Aggarwal R. Common pitfalls in statistical analysis: Logistic regression. Perspect Clin Res. 2017;8(3):148-51.

27. Rothman KJ. No adjustments are needed for multiple comparisons. Epidemiology (Cambridge, Mass). 1990;1(1):43-6.

28. Feise RJ. Do multiple outcome measures require p-value adjustment? BMC Medical Research Methodology. 2002;2(1):8.

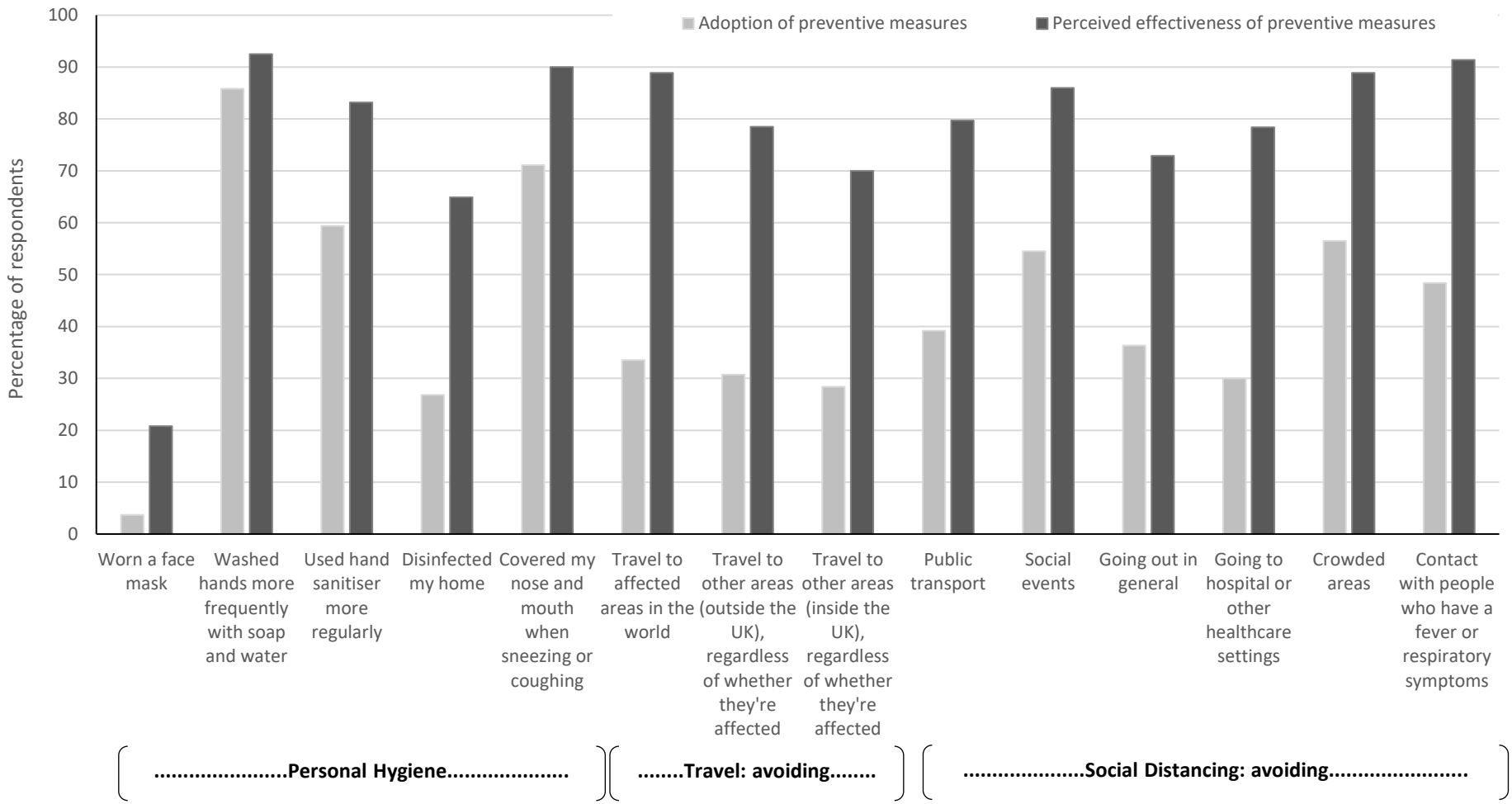
29. Bults M, Beaujean DJ, Richardus JH, Voeten HA. Perceptions and behavioral responses of the general public during the 2009 influenza A (H1N1) pandemic: a systematic review. Disaster Med Public Health Prep. 2015;9(2):207-19. doi: 10.1017/dmp.2014.160.

30. Ahmed F, Zviedrite N, Uzicanin A. Effectiveness of workplace social distancing measures in reducing influenza transmission: a systematic review. BMC Public Health. 2018;18(1):518. doi: 10.1186/s12889-018-5446-1.

31. Goodwin R, Sun S. Public perceptions and reactions to H7N9 in Mainland China. J Infect. 2013;67(5):458-62. doi: 10.1016/j.jinf.2013.06.014. Epub Jul 5.

32. Jang WM, Cho S, Jang DH, et al. Preventive Behavioral Responses to the 2015 Middle East Respiratory Syndrome Coronavirus Outbreak in Korea. Int J Environ Res Public Health. 2019;16(12).(pii):ijerph16122161. doi: 10.3390/ijerph.

33. UK_Government. Support for those affected by Covid-19 2020 [Available from: https://www.gov.uk/government/publications/support-for-those-affected-by-covid-19.


Adoption of preventive measures
Perceived effectiveness of preventive measures
Percentage of respondents
100
90
80
70
60
50
40
30
20
10
0
Worn a face mask
Washed hands more frequently with soap and water
Used hand sanitiser more regularly
Disinfected my home
Covered my nose and mouth when sneezing or coughing
Travel to affected areas in the world
Travel to other areas (outside the UK), regardless of whether they're affected
Travel to other areas (inside the UK), regardless of whether they're affected
Public transport
Social events
Going out in general
Going to hospital or other healthcare settings
Crowded areas
Contact with people who have a fever or respiratory symptoms
.....Personal Hygiene.....
.....Travel: avoiding.....
.....Social Distancing: avoiding.....

Sample – Weighting Strategy

The weighting approach used rim weighting to adjust to population estimates of: age by sex; UK geographical region counts; ethnic group.

The age by sex and region counts were extracted from the ONS mid-year population estimates (1), and the ethnic group counts from the Labour Force Survey (Annual Population Survey) (2). To allow for the different sources of population estimates, the rim weighting was carried out on the proportions rather than population totals.

Age was grouped into seven categories: 18 to 24; 25 to 34; 35 to 44; 45 to 54; 55 to 64; 65 to 74; 75 or older. So the age and sex groups had 14 categories.

The reported ethnicity was grouped into nine categories: white; mixed / multiple ethnic groups; Indian; Pakistani; Bangladeshi; Chinese; any other Asian background; black African / Caribbean / other; and any other ethnic group or missing.

The rim weighting was carried out in two stages. At the first stage, the sample was weighted to region counts and age by sex groups only. This put the sample back into the correct proportion for UK geographical regions which corrects for the differential non-response. In the same stage, the age and sex groups were also adjusted to make sure that the final weighted profile was as close to the population as possible.

The second stage of rim weighting adjusted to all four measures, using the first stage weights as the starting weights. The adjustment factor between the first and second stage weights were trimmed at the 1st and 99th percentiles to dampen the extreme weights which improves efficiency. The final weights were calculated as the first stage weights multiplied by the trimmed adjustment factor for the second stage.

Sample profile

	Population of United Kingdom Profile	COMPLETED SURVEY - UNWEIGHTED (%)	COMPLETED SURVEY - WEIGHTED (%)
GENDER			
Male	48.9%	47.4%	48.6%
Female	51.1%	52.6%	51.4%
AGE			
18 to 24	10.9%	10.3%	11.1%
25 to 34	17.3%	14.0%	14.4%
35 to 44	16.1%	18.8%	19.3%
45 to 54	17.5%	16.8%	17.5%
55 to 64	15.0%	13.7%	14.6%
65 to 74	12.6%	20.5%	17.9%
75+	10.5%	6.0%	5.2%
REGION			
North East	4.0%	4.7%	4.4%
North West	11.0%	11.7%	10.9%
Yorkshire & Humber	8.2%	8.4%	8.0%
East Midlands	7.2%	7.5%	7.7%
West Midlands	8.9%	8.3%	8.4%
East of England	9.3%	9.4%	9.1%
London	13.4%	11.3%	13.1%
South East	13.7%	13.1	13.0%
South West	8.4%	9.9%	9.6%
N. Ireland, Scotland, Wales	15.7%	15.7%	15.9%

ETHNICITY			
White	86.3%	94.2%	93.9%
Mixed/Multiple ethnic groups	1.1%	1.6%	1.7%
Indian	2.9%	1.0%	1.1%
Pakistani	1.9%	0.52%	0.54%
Bangladeshi	0.8%	0.14%	0.15%
Chinese	0.5%	0.43%	0.46%
Any other Asian background	1.2%	0.14%	0.16%
Black/African/Caribbean/Black British	3.3%	0.95%	1.0%
Other ethnic group / DK	1.9%	1.0%	1.0%

REFERENCES

1. Office for National Statistics. Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019 2020 [Available from: www.ons.gov.uk/releases/populationestimatesfortheukenglandandwalesscotlandandnorthernirelandmid2019.
2. Office for National Statistics. Annual Population Survey/Labour Force Survey 2020 [Available from: https://www.nomisweb.co.uk/sources/aps.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **PAGE 1 and 2**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found **PAGE 2**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported **PAGE 4**
Objectives	3	State specific objectives, including any prespecified hypotheses **PAGE 4**
Methods		
Study design	4	Present key elements of study design early in the paper **PAGE 5-6**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection **PAGE 5-6**
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants **PAGE 5-6**
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable **PAGE 5-7**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **PAGE 5-6**
Bias	9	Describe any efforts to address potential sources of bias **PAGE 5 and 7**
Study size	10	Explain how the study size was arrived at **PAGE 5**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why **PAGE 7**
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding **PAGE 7**
		(*b*) Describe any methods used to examine subgroups and interactions **PAGE 7**
		(*c*) Explain how missing data were addressed **N/A**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **PAGE 7**
		(*e*) Describe any sensitivity analyses **N/A**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed **PAGE 8**
		(b) Give reasons for non-participation at each stage **N/A**
		(c) Consider use of a flow diagram **N/A**
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders **PAGE 8-15**
		(b) Indicate number of participants with missing data for each variable of interest **Tables 1-3**
Outcome data	15*	Report numbers of outcome events or summary measures **PAGE 8-15**
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **PAGE 11-15; Tables 2-3**

		(*b*) Report category boundaries when continuous variables were categorized **PAGE 8-15; Tables 1-3**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **N/A**
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **PAGE 10-15; Tables 2-3**
Discussion		
Key results	18	Summarise key results with reference to study objectives **PAGE 16**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias **PAGE 17**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence **PAGE 16-18**
Generalisability	21	Discuss the generalisability (external validity) of the study results **PAGE 17-18**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based **PAGE 19**

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.