# Perceived risk factors for severe Covid-19 symptoms and their association with health behaviours: Findings from the HEBECO study

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**Abstract**

**Background:** There remains uncertainty about Covid-19 risk factors. We examined UK adults' risk perceptions for severe Covid-19 symptoms and whether engaging in concurrent health behaviours is associated with risk perceptions.

**Methods:** Cross-sectional analysis of data from the HEBECO study where 2206 UK adults classified potential factors (age 70+, ethnic minority, medical comorbidities, vaping, smoking cigarettes, alcohol drinking, regular physical activity, being overweight, eating unhealthy foods, using nicotine replacement therapy – NRT, lower income, poor housing, being a keyworker) as either increasing, decreasing, or having no impact on severe Covid-19 symptoms. Logistic regressions examined whether engaging in health behaviours was associated with risk perceptions after adjusting for socio-demographic characteristics, health conditions and other behaviours.

**Results:** The great majority (89-99%) of adults classified age 70+, having comorbidities, being a key worker, overweight, and from an ethnic minority as increasing the risk. People were less sure about alcohol drinking, vaping, and nicotine replacement therapy use (17.4-29.5% responding 'don't know'). Relative to those who did not, those who smoked tobacco, vaped and consumed alcohol had significantly (all $p<0.015$) higher odds (aORs=1.58 to 5.80) for classifying these behaviours as 'no impact' or 'decreasing risk', and lower odds (aORs=.25 to .72) for classifying as 'increasing risk'. Similarly, eating more fruit and vegetables was associated with classifying unhealthy diet as 'increasing risk' (aOR=1.37,1.12-1.69), and exercising more with classifying regular physical activity as 'decreasing risk' (aOR=2.42,1.75-3.34).

**Conclusions:** Risk perceptions for severe Covid-19 symptoms were lower for adults' own health behaviours, evidencing optimism bias.

**Implications:** These risk perceptions may form barriers to changing one's own unhealthy behaviours or make one less responsive to interventions that refer to the risk of Covid-19 as a motivating factor. Thus, in some cases risk perceptions could help sustain unhealthy behaviours and exacerbate inequalities in health behaviours and outcomes.

**Keywords:** covid-19, risk perceptions, health behaviours, cross-sectional, optimism bias

**Protocol pre-registration:** https://osf.io/392sp; DOI: 10.17605/OSF.IO/392SP

## Background

As of December 2020, the Covid-19 pandemic has resulted in over 1.5 million deaths worldwide and almost 66 million confirmed infections caused by the SARS-CoV-2 virus (WHO, 2020). Research on risk and protective factors for severe Covid-19 outcomes such as hospitalisation and mortality continues to develop. Notwithstanding the importance of context, resources and social opportunities, risk perceptions can be important influences on health behaviours and behaviour change, with inaccurate beliefs or cognitive biases leading to missed opportunities or misguided behaviours that could pose further risk and contribute to health inequalities (Branstrom, Kristjansson, & Ullen, 2006; Brewer et al., 2007; Ferrer & Klein, 2015; Michie, van Stralen, & West, 2011a; Shahab, McGowan, Waller, & Smith, 2018)). Understanding the beliefs that adults hold regarding risk factors for severe Covid-19 symptoms and their correlates could contribute to the design or implementation of health campaigns and interventions during the current and future pandemics or other health crises.

Risk perceptions are on a pathway to behaviour or behaviour change in many models of health behaviours, including the Health Belief Model, the Extended Parallel Process Model (EPPM, (Witte, 1992)), Protection Motivation Theory (Rogers, 1975) and the Capability, Motivation and Opportunity-Behaviour Model (COM-B, (Michie, van Stralen, & West, 2011b)). Risk perception is associated with, or predictive of, a range of health behaviours, including taking part in vaccinations (Brewer et al., 2007), cancer screening (Katapodi, Lee, Facione, & Dodd, 2004) and engaging in health protective behaviours during the Covid-19 pandemic (Wise, Zbozinek, Michelini, Hagan, & Mobbs, 2020). A number of cognitive biases, such as optimism bias (overestimating and underestimating chances of experiencing favourable and unfavourable events, respectively (Weinstein, 1980)), illusory control (Presson & Benassi, 1996), cognitive consistency (Gawronski, 2012) and confirmation bias (Nickerson, 1998) can undermine the motivation to engage in health-protective behaviours. For example, unrealistic optimism bias was found among smokers who were underestimating the health risk of smoking, which was associated with lower quit rates and motivation to quit (Dillard, McCaul, & Klein, 2006).

A number of factors have already been identified as important risks for severe Covid-19 symptoms, including older age, higher body mass index, medical comorbidities (e.g. diabetes, severe asthma), ethnic minority background, male sex, socioeconomically disadvantaged background, and occupation (e.g. healthcare professional) (Aveyard et al., 2020; CDC, 2020; Ioannou et al., 2020; NHS, 2020; The OpenSAFELY Collaborative et al., 2020; Ward et al., 2020). Additionally, certain health behaviours have also been suggested to impact on Covid-19 infections and outcomes, such as unhealthy diet (Butler & Barrientos, 2020), low physical activity (Sallis, Adlakha, Oyeyemi, & Salvo, 2020), and vitamin D deficiency caused by spending insufficient time outdoors and not exposing skin to the sun (Grant et al., 2020; Rhodes, Subramanian, Laird, & Kenny, 2020). Smoking history was also shown to be associated with Covid-19 outcomes, but the findings remain uncertain regarding the causality, with some studies pointing to a protective effect of nicotine use, which could have implications for the use of electronic cigarettes (e-cigarettes, or vaping) and nicotine replacement therapy (Farsalinos, Barbouni, & Niaura, 2020; Farsalinos, Niaura, et al., 2020; Hartmann-Boyce & Lindson, 2020; Simons, Shahab, Brown, & Perski, 2020). Importantly, research on the Covid-19 risk factors to date has been marked by uncertainty and has often suffered from important limitations including small sample sizes, reliance on observational and poorly controlled data, and incomplete data on health behaviours and other risk factors among those who were diagnosed or treated for Covid-19 (Simons et al., 2020; The OpenSAFELY Collaborative et al., 2020).

Beliefs regarding risky or protective behaviours may have already shaped some of the behaviours in the general population during the pandemic. For example, a minority of current smokers and e-cigarette users reported attempting to quit smoking or vaping, respectively, due to Covid-19 (ASH, 2020; Tattan-Birch et al., 2020). Meanwhile, in France early reports that nicotine may be protective against Covid-19 (Changeux, Amoura, Rey, & Miyara, 2020; Miyara et al., 2020) led to a rapid increase in purchasing of nicotine replacement therapy (Dalton, 2020). In Iran, cases of alcohol poisoning have been registered following unfounded suggestions that alcohol could treat or kill the virus causing Covid-19 (Aghababaeian, Hamdanieh, & Ostadtaghizadeh, 2020; Shokoohi, Nasiri, Sharifi, Baral, & Stranges, 2020).

Understanding adults' risk perceptions for severe Covid-19 symptoms and their correlates could contribute to the design and implementation of health promotion programmes during the current pandemic or other health crises. In this study we examined risk perceptions of adults for a range of factors that could be related to severe Covid-19 symptoms. These included socio-demographic and health characteristics (i.e. older age, medical comorbidities, ethnic minority, being a key worker, vitamin D deficiency, and poor housing and lower income as proxies for poor living conditions) and health behaviours (smoking, e-cigarette use, NRT use, alcohol use, physical activity, unhealthy diet, spending time in the sun). As part of the 1-month follow-up assessment (conducted between June-September 2020) the respondents reported on risk perceptions for a range of.

The present study aims to answer two research questions:

1. Among UK adults during the early stages of the Covid-19 pandemic (June-September 2020), to what extent were older age, medical comorbidities, ethnic minority, being a key worker, vitamin D deficiency, and poor housing and lower income as proxies for poor living conditions, smoking, e-cigarette use, NRT use, alcohol use, physical activity, unhealthy diet, spending time in the sun believed to (i) increase risk, (ii) decrease risk, or (iii) have no impact on having more severe Covid-19 symptoms?
2. To what extent did risk perceptions about health behaviours (tobacco smoking, e-cigarette use, alcohol drinking, physical activity, eating fruit and veg) and risk of severe Covid-19 symptoms differ according to participants' own engagement in these behaviours?
3. What other factors were perceived as increasing the risk for Covid-19 among adults?

## Methods

### Design

Data came from an ongoing longitudinal study of HEalth BEhaviours during the Covid-19 pandemic (HEBECO), among UK adults. For project details and the survey wording see https://osf.io/sbgru/. The study involved cross sectional analysis of data from the study baseline (including socio-demographic characteristics used as predictors – see Measures below for details; collected between 23rd April 2020 till 25th July) and 1-month follow-up (risk classification, concurrent socio-demographic characteristics and health behaviours; collected from 6th June 2020 till 26th August). The study protocol was pre-registered on Open Science Framework (https://osf.io/392sp). To increase sample representativeness, the recruitment campaign involved sharing study materials and invitations via multiple channels, including unpaid and paid advertisements on social media (e.g. Facebook, Twitter, Reddit), email campaign across the networks of UCL, other universities, Public Health England, Cancer Research UK, charities and local authorities across the UK.

**Sample**

The data came from a convenience sample of UK-based participants who were (a) recruited into the study baseline between 23rd April 2020 and 28th August 2020 and (b) who were successfully followed-up at 1 month and answered questions on risk perceptions that were added to the 1-month follow-up survey.

**Measures**

**Outcome measures assessed at 1-month follow-up**

Risk perceptions of individual factors for severe Covid-19 symptoms were assessed by one question: "How do you think the following may affect, or not, the risk of having more severe symptoms of Covid-19?" The answer options were: lowers risk, no impact, increases risk, and don't know. The list of factors were: being 70 years old and older, being from an ethnic minority, existing medical conditions, regular physical activity, smoking cigarettes, using e-cigarettes (vaping), being overweight, eating unhealthy foods, using nicotine replacement therapy (e.g. nicotine gum, patch), vitamin D deficiency, spending time in the sun, drinking alcohol, lower income, poor housing, being a key worker.

**Correlates and confounding variables – health behaviours**

Health behaviours assessed at 1-month follow-up included: (1) current tobacco smoking (including smoking cigarettes or smoking any other tobacco product, daily or non-daily; dichotomised: yes/no), (2) current e-cigarette use (daily or non-daily, dichotomised: yes/no); (3) physical activity levels (assessed as the level of adherence to the World Health Organisation recommendations for weekly aerobic and strength training exercises among adults, categorised into: meeting no recommendations, meeting recommended levels of either strength training of (≥2 days strength training/week vs not; ≥150 min aerobic activity vs not (REF to be added), and meeting recommendations for both strength and aerobic training); (4) fruit and vegetable consumption (a few times per day vs less often, including not at all); and (5) weekly alcohol consumption divided into three levels: no alcohol drinking (0 units in the past week), low risk drinking (≤14 units per week), and high risk drinking (>14 units per week; UK Government, 2016). To compute this variable, assuming a 30-day-long month we converted the frequency of alcohol consumption in the past month into past week consumption (everyday=7, a few times per week=3.5, once a week=1, two to three times in the past month=0.63, once in the past month=0.25, and never in the past month=0) and multiplied it by the number of alcohol units consumed on an average session.

**Correlates and confounders – socio-demographic and health characteristics**

Additional correlates and potential confounders assessed at baseline included age (<35, 36-69, 70+; these age cut-offs were selected to divide adults into low, moderate, and high risk groups, in line with the messaging about the pandemic and shielding of those aged 70+); gender (female vs all other); ethnicity (white ethnicity vs all other); education (post-16 education or higher vs not); any health condition (assessed through a single item 'Do you have a health condition?' with answers dichotomized into yes vs no/prefer not to say This question was selected as it was expected to capture data on any health condition that could have impact on the different outcomes of interest); BMI (≤24.9, 25-29.9, ≥30 kg/$m^2$, unknown) living with vulnerable persons (yes/no); working as a key worker (yes/no); as well as pre-Covid-19 annual household income (high, ≥50 000 GBP, vs medium-low, <50 000 GBP, vs prefer not to say) and housing tenure (mortgage or own outright vs all other). Both income and housing tenure are important correlates of health behaviours (Beard et al., 2020).

Additional correlates and potential confounders assessed at 1-month follow-up were: employment (full time or part-time vs all other), perceived risk of Covid-19 to one's health (no or minor risk vs all other: major risk or significant risk or don't know). Finally, the analyses were adjusted for the timing of the follow-up survey to control for the changes in risk perception in light of new information on risks being published (up to 14th June that marked the period of the strictest social distancing measures in the UK, 15th-30th June, and from 1st July due to very few people responding to the follow-up in the second half of July and in August).

**Additional factors perceived as increasing/decreasing the risk for severe Covid-19 symptoms**

Participants were able to provide additional comments in the box provided "If you wish, please share what else you think can impact the risk of having more severe symptoms of COVID-19? Please include information on whether it increases or decreases the risk." The comments were analyses thematically and tallied by one of the co-authors and checked by the first author.

**Ethics and Data management**

The study meets relevant ethical guidelines, including adherence to the legal requirements in the UK and has been approved by UCL Research Ethics Committee at the UCL Division of Psychology and Language Sciences (CEHP/2020/579) as part of the larger programme 'The optimisation and implementation of interventions to change behaviours related to health and the environment'. Participants provided informed consent before joining the study. The study data are collected and managed using REDCap electronic data capture tools (Harris et al., 2009) hosted at University College London. REDCap (Research Electronic Data Capture; https://projectredcap.org/).

**Analyses**

The sample was weighted to Census and Annual Population Survey mid-year estimates for age, gender, ethnicity, country of living, education and household income (Office for National Statistics, 2020b). Analyses included complete cases only. Data analysis was conducted in IBM SPSS 25. Multiple comparisons were corrected for false discovery rate using the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995).

For the first research question, weighted percentages were calculated for the selection of each of the four answer options (lowers risk/no impact/increases risk/don't know) for each potential Covid-19 risk factor.

For the second research question, separate univariable analyses (chi-square) were conducted to assess the relationship between engaging in a health behaviour at the 1-month follow-up (smoking cigarettes, e-cigarette use, nicotine replacement therapy use, alcohol drinking, regular physical activity, and eating unhealthy diet) with the 4-level classifications of risk for the corresponding behaviours. Multivariable logistic regression models were then conducted to identify the correlates of selecting the following responses on the risk factors: (i) increase risk vs all other, (ii) decrease risk vs all other, and (iii) no impact vs all other. This analysis was performed for answer options (i.e. dependent variable) that were endorsed by at least 3% of the respondents in order to ensure a sufficient sample size. Odds Ratios (ORs) and associated 95% Confidence Intervals (CIs) were calculated. The multivariable analyses were conducted with the adjustment for all the variables listed above as per the pre-registered protocol.

For the third research question one researcher (DK) conducted the thematic analysis and another (AH) checked the coding. The list of emerging themes and their tallies (unweighted) are presented.

**Departures from the pre-registered protocol**

The pre-registered protocol for the data analysis specified that the same multivariable analysis would be conducted for each of the three answers (increase, decrease, no impact vs all other) and for each of the risk factors. After completing the analyses for research question 1 it was decided that the regression models would only be run for answers (among the increase, decrease and no impact) for whom data was available on the concurrent health behaviours and which were endorsed by at least 3% of respondents. Predicting rare events can be challenging (King & Zeng, 2017), and additionally, it was judged that in the context of the current findings identifying predictors of these rare responses would have limited added public health benefit. For the same reasons the planned sensitivity analyses involving multinomial regressions with four levels (increases risk/no impact/don't know/decreases risk) were not performed. Secondly, after inspecting the data we have made small changes to the variables used as correlates in the model. The original protocol specified that alcohol consumption would be calculated using the established three-item AUDIT-C questionnaire and classified into a three level variable: no consumption, low risk consumption (AUDIT-C scores of core 1-3 out of 12), and high and increasing risk consumption (score ≥5/12) (Bradley et al., 2007). However, the wording of the first AUDIT-C question (on the frequency of consumption) was accidentally changed as part of the 1-month follow-up survey and it was not possible to calculate the standardised AUDIT-C score. Finally, we initially planned to use a time covariate for the follow-up date that had more than three levels (up to 14th June, 15th-30th June, 1st July-15th July, 16th July-31st July, 1st-15th August, 16th-30th August, 1st-15th September), but due to small counts in some of the pre-specified time period categories this variable was replaced by a 3-level variable described above. Finally, we added research question 3 to report the findings from the comments.

**Sensitivity analyses**

We conducted a number of sensitivity analyses. First of all, we replicated all analyses using unweighted data. Secondly, we also used a different classification of household income (using cut-off values: <£25.000 vs ≥ £25.000) that was closer to the median household income in the UK of £30.800 (Office for National Statistics, 2020a). In the analysis of the correlates of risk perceptions for alcohol consumption we used a continuous alcohol weekly consumption score (frequency*units). We also computed a variable on frequency of heavy episodic drinking (HEDs; based on the third AUDIT-C question that assesses the frequency of having at least 6 units of alcohol in a single session (Bradley et al., 2007), categorised into: not drinking at all/no HEDs sessions, drinking but less than weekly HEDs, at least weekly HEDs.

## Results

The analysis included n=2206 (unweighted; n=1921 weighted) UK-based adults, of whom 53.4% (weighted %) were female, 71.1% were aged 36-69, and 70.3% had post 16 years of age education (Table 1).

Table 2 reports on the risk perceptions of the individual factors. The great majority of adults classified 'being 70 years old and older', having 'existing medical conditions', 'being from an ethnic minority', 'being a key worker', and 'being overweight' as increasing the risk for severe Covid-19 symptoms.

Table 3 reports results from the univariable analysis. In all cases, engagement in a given health behaviour was associated with classification of risk (all p<0.001). Table 4 presents (as a summary) the fully adjusted ORs and 95% CI for engagement in a given health behaviour as a predictor of classifying the corresponding health behaviour as increasing risk, decreasing risk or having no impact on severe Covid-19 symptoms, vs all others. See Supplementary Material 1 (at the end of the document, and here: https://osf.io/mwtfz/) for the detailed findings for all the fully adjusted models run for this study. The findings did not change in the sensitivity analyses using unweighted data (see Supplementary Material 2, available here: https://osf.io/b3a7v/) with the exception of three models – as marked in Table 4 – one model for nicotine replacement therapy and two for eating unhealthy foods where the correlates did no longer meet the significance levels, albeit the ORs were very similar. In the sensitivity analyses of risk perception for alcohol consumption, the weekly HEDs sessions showed a very similar pattern of associations to that for categorical variable on weekly units consumed, but a continuous variable of weekly alcohol unit consumption was non-significant (See Supplementary Material 3, available here: https://osf.io/b3a7v/).

For behaviours that are perceived to be unhealthy or to carry even minimal health risk in general (smoking, drinking alcohol, e-cigarette use), engaging in these behaviours was associated with lower odds for classifying these behaviours as increasing the risk for severe Covid-19 symptoms, and with higher odds of classifying that behaviour as having no impact or decreasing the risk for severe Covid-19 symptoms. Similarly, both current tobacco smokers and e-cigarette users had higher odds of classifying the use of nicotine replacement therapy as decreasing the risk for severe Covid-19 symptoms.

Those who engaged in the recommended levels of one or both types of physical activity, compared with those who did not, had significantly higher odds for classifying regular physical activity as decreasing risk for severe Covid-19 symptoms or having no impact. Those who reported eating fruit and vegetables a few times per day, versus those who did not, were more likely to consider unhealthy diet as increasing the risk for severe Covid-19 symptoms and less likely to classify it as having no impact.

As presented in Supplementary Material 1, the classification of individual factors as increasing or decreasing the risk for severe Covid-19 symptoms was either not at all or only weakly associated with health behaviours that were different to the target factor in fully adjusted models. For example, current tobacco smoking behaviour was not associated with risk perception of alcohol consumption, and vice-versa.

A sub-sample of 488 participants (n=358 (73.4%) were women, aged M=51.9, SD=14.4, unweighted) provided additional comments regarding factors they perceived to be related to Covid-19. Some of the comments might have included factors associated with Covid-19 infection and not only symptom severity. Most comments listed more than one factor, e.g. “Increased risk - male, overweight, diabetes, those who are not following social distancing or good handwashing.”. The identified themes related to potential risk factors were (*marks new factors that were not included in the list of factors to rate): ill physical health and having a health condition, including diabetes, heart or respiratory condition (n=130), not following guidelines for social distancing or hygiene* (n=98), gender* (n=42), other sociodemographic characteristics, e.g. education or living alone (n=42), poor mental health or stress that could lower immunity* (n=36), the degree of virus exposure* (n=35), overweight or obesity (n=18), specific blood type* (n=22), genetic predisposition* (n=13), ethnic minority (n=12), age (n=12), diet (n=9), physical activity (n=13), vitamin deficiency (n=9), certain medications, e.g. for blood pressure* (n=4), lack of sleep* (n=4), smoking (n=4), alcohol consumption (n=3), drug use* (n=2), access to healthcare* (n=2), air pollution* (n=1).

## Discussion

To our knowledge, this is the first study to investigate the risk perceptions regarding health behaviours alongside other factors for severe Covid-19 symptoms among UK-based adults. The study has resulted in noteworthy findings that can inform future public health communication, programmes and research. Firstly, UK adults were well aware of the factors that had been repeatedly presented as risk factors for severe Covid-19 by public health authorities in the UK at the time of data collection on risk perceptions (i.e. June-September 2020). Secondly, risk perceptions aligned with general classification of behaviours and conditions into healthy and unhealthy. Healthy behaviours (e.g. regular physical activity) tended to be classified as decreasing the risk for severe Covid-19 symptoms. Conversely, unhealthy behaviours (e.g. eating unhealthy foods) were classified as increasing the risk. Finally, one's own health behaviours were strongly predictive of risk classification for these behaviours, showing optimism bias (Bottemanne, Morlaas, Fossati, & Schmidt, 2020; Sharot, 2011). Thus, for example, current tobacco smokers, e-cigarette users and alcohol drinkers were less likely to consider their own behaviours of smoking, vaping and drinking, respectively, as factors that increased the risk for severe Covid-19 symptoms than those who did not engage in these behaviours.

The greatest uncertainty regarding the impact of health conditions and behaviours on the risk of severe Covid-19 symptoms, as indicated by answers 'don't know', existed for the use of nicotine replacement therapy, drinking alcohol, and vitamin D deficiency. These findings are in line with the evolving evidence base regarding the association between these factors and Covid-19. Interestingly, only a small minority of adults classified smoking cigarettes (6.0%) and vaping (3.4%) as decreasing the risk for severe Covid-19 symptoms, suggesting that the hypotheses and the new scientific findings pertaining to nicotine use possibly lowering risk for infection or severe Covid-19 symptoms (Farsalinos, Barbouni, et al., 2020; Farsalinos, Niaura, et al., 2020) have not been widely noticed by the general population, at least during the early stages of the pandemic when this study's data were collected.

The open-ended comments provided by a sub-sample of the respondents tended to focus on poor physical health, but also poor mental health and low adherence to social distancing measures as risk factors for severe Covid-19.

### Implications

The findings concerning the optimism bias in risk perception for Covid-19 have several implications. First of all, they suggest that in the context of mixed message communication (e.g. regarding the relationship between smoking, nicotine use and vaping, and Covid-19) or in the absence of clear messaging regarding risk (e.g. for physical activity) there may be a tendency to interpret one's own behaviour as favourable during the pandemic (i.e. not increasing the risk for severe Covid-19 symptoms, or as being protective, or at least not having an impact on Covid-19 severity). This in turn could exacerbate substantial inequalities in health-protective behaviours and their outcomes during the pandemic. It will be important to monitor these beliefs and associated behaviours and behaviour change. Another area of research could investigate whether holding certain risk perceptions about one's own health behaviours with regards to Covid-19 is associated with adherence to social distancing measures or other protective behaviours, such as taking up vaccinations for Covid-19 or use of face coverings.

The findings also suggest that beliefs in risk factors for severe Covid-19 symptoms in the UK reflected the contemporary reports on risks in the governmental and public health media in the UK (as listed in the

introduction). This could be a sign of effective communication on the part of public health bodies in the UK. It will be important to maintain appropriate and effective channels of communication as the pandemic progresses and knowledge on the risks and protective effects of Covid-19 is updated. At the same time, however, health promotion campaigns during the current and future pandemics should consider and address the possibility that certain risk perceptions may form additional barriers to positive health behaviour change and make one less responsive to interventions that refer to the risk of COVID as a motivating factor. Such risk perceptions should also be measured when evaluating the impact of such campaigns.

**Strengths and Limitations**

The study benefited from including a wide range of covariates, validated outcome measures and timely assessment during an ongoing pandemic, increasing robustness and reducing the risk of recall bias and confounding. It also suffers from some limitations. This being a cross-sectional analysis we cannot determine the direction of causality and it is possible that the respondents have changed their behaviour in accordance with their beliefs, or vice-versa. Additionally, although the sample at baseline was weighted for the UK Census data, due to attrition it became less representative at 1-month follow-up and the sample with complete data included in the current analyses comprised a more educated population with over representation of female gender and white ethnicity. Further research is required to examine whether our findings hold among ethnic minority and socially disadvantaged groups. Participants were asked to select only from four answer options for each factor listed (i.e. increases risk, lowers risk, no impact, and don't know) and therefore we could not assess the strength of belief, which can also help explain the ceiling effect reached for endorsement of the common risk factors. However, previous studies on beliefs in risk factors that used 5-point scale have commonly dichotomised the answers for the analysis (e.g. 'increases risk' vs all other) (Shahab et al., 2018). Finally, severe Covid-19 symptoms were not defined as part of the question in the survey and could have been interpreted by participants in different ways. The question did not aim to assess factual knowledge of the potential risk factors and their association with the different possible Covid-19 outcomes (e.g. becoming infected, hospitalisation among those who are infected, death among those who are hospitalised), but rather to assess more subjective classification of risks.

**Conclusion**

During the early stages of the Covid-19 pandemic, beliefs in risks for severe Covid-19 symptoms were in line with general classifications of health conditions and behaviours as healthy or unhealthy, and were significantly inversely associated with adults' own health behaviours in a way that is strongly suggestive of optimism bias. These findings could have implications for the design and implementation of health policy and programmes.

**Supplementary Materials**

**SM1** Results from fully adjusted models (weighted analysis); available here: https://osf.io/mwtfz/
**SM2:** Sensitivity Analyses (unweighted data); available here: https://osf.io/b3a7v/
**SM3:** Sensitivity Analyses using different alcohol variables (weighted data)**;** available here: https://osf.io/b3a7v/

**Author Contributions**

AH and LS co-lead on the HEBECO project. AH conceptualised the study, analysed the quantitative data, and prepared the first version of the manuscript. JB, DK, CG and TC contributed to the survey design. JB, CG, SJ, DK, MZ, and LS contributed to the study design. DK conducted the thematic analysis. All authors contributed to the preparation of, and approve, the final version of the manuscript. The views expressed in this article are those of the authors and are not necessarily those of Public Health England or the Department of Health and Social Care.

**Declaration of Conflicting Interests**

JB has received unrestricted research funding to study smoking cessation from companies who manufacture smoking cessation medications (Pfizer and J&J). All other author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article. All authors declare no financial links with tobacco companies or e-cigarette manufacturers or their representatives.

**Funding**

This project is partially funded by an ongoing Cancer Research UK Programme Grant to UCL Tobacco and Alcohol Research Group (C1417/A22962) and by SPECTRUM a UK Prevention Research Partnership Consortium (MR/S037519/1).

**Acknowledgements**

We are grateful to all participants who have been supporting our research. We would like to thank Public Health England, and particularly members of the Behavioural Insights at Public Health England and of the COVID-19 Behavioural Science and Insights Unit, Public Health Advice, Guidance and Expertise (PHAGE) function and National COVID-19 Response Centre (NCRC) for providing feedback on the survey wording. We would like to thank Public Health England, Cancer Research UK, local authorities, Mayors' offices, as well as charities and other organisations in the UK, including the Asthma UK and British Lung Foundation Partnership, for supporting our recruitment campaign. We would like to also acknowledge Verena Schneider's assistance with preparation of variables for analyses and Rhea Kohli's assistance with the preparation of supplementary materials.

**Table 1:** Sample characteristics (ns and % are weighted)

| **Characteristics assessed at baseline** | **Excluded listwise (due to missing data (n=889)** | **Included (complete cases) (n=1921)** | ***p*** |
|---|---|---|---|
| Female vs all other[a] | 49.0 (436) | 53.4 (1026) | .041 |
| White vs all other[a] | 84.9 (751) | 91.5 (1757) | <0.001 |
| Age <35, | 36.8 (326) | 17.7 (340) | <0.001* |
| 36-69, | 58.0 (514) | 71.1 (1366) | |
| 70+ | 5.2 (46) | 11.2 (216) | |
| High school or higher vs lower | 61.0 (540) | 70.3 (1352) | <0.001 |
| Income ≥50 000 GBP vs | 17.8 (157) | 17.9 (344) | <0.001 |
| <50 000 GBP | 70.2 (621) | 75.0 (1440) | |
| prefer not to say | 12.0 (106) | 7.1 (137) | |
| Mortgage/own outright | 53.2 (470) | 67.1 (1289) | <0.001 |
| Any health condition vs all other[a] | 38.5 (341) | 45.7 (879) | <0.001 |
| BMI 4 levels: ≤24.9, 25-29.9, ≥30, unknown | 46.6 (383) | 39.4 (756) | 0.102 |
| Overweight | 29.6 (243) | 34.6 (664) | |
| Obese | 18.4 (151) | 21.2 (408) | |
| Data on BMI not available | 5.5 (45) | 4.8 (93) | |
| Living with vulnerable persons yes/no | 15.1 (134) | 16.2 (311) | .483 |
| Working as a key worker vs all other | 24.3 (215) | 23.8 (458) | .789 |
| **Characteristics assessed at 1-month follow-up** | (87<n<215[b]) | (n=1921) | |
| Employment (FT or PT) vs all other | 44.2 (95) | 48.6 (935) | .214 |
| Covid-19 risk Minor/No risk vs all other | 41.8 (89) | 41.4 (795) | .906 |
| Any tobacco smoking vs not | 36.7 (62) | 18.6 (358) | <0.001 |
| Vaping vs not | 11.9 (20) | 14.7 (282) | .327 |
| Alcohol – no alcohol consumed in past week | 12.6 (11) | 22.6 (434) | <0.001 |
| ≤14 units of alcohol in the past week | 31.0 (27) | 53.6 (1030) | |
| >14 units of alcohol in the past week | 56.3 (49) | 23.8 (457) | |
| Fruit&Veg a few times per day vs not | 55.6 (60) | 56.2 (1080) | .892 |
| Physical activity: meetings MVPA and MSA | 12.6 (16) | 16.0 (308) | .906* |
| Meets either MVPA or MSA | 42.5 (54) | 36.4 (700) | |
| Meets none | 44.9 (57) | 47.5 (913) | |

a=including answer options 'prefer not to say; b=the sample for individual comparisons differed due to different levels of missing data at follow-up 1; GBP=Great British Pounds, BMI=body mass index, FT=full time, PT=part time, MVPA =moderate to vigorous physical activity (aerobic), MSA = muscle strength training; *linear by linear association

**Table 2:** Classification of factors in terms of risk or protective effect on severe Covid-19 symptoms among UK-based adults (organised in the order of agreement with increased risk). (all participants) - weighted N and %.

| **Potential risk factors for Covid-19** | **Decrease risk** | **No impact** | **Increase risk** | **Don't know** |
|---|---|---|---|---|
| **Socio-demographic and health conditions** | **% (N weighted) agreement** | | | |
| Existing medical conditions | 0 (1) | 0.5 (9) | 98.8 (1898) | 0.7 (14) |
| Being 70 years old and older | 0 (0) | 1.6 (30) | 97.4 (1872) | 1.0 (19) |
| Being overweight | 0.05 (10) | 4.8 (92) | 90.8 (1744) | 3.9 (76) |
| Being a key worker | 1.2 (22) | 6.1 (117) | 89.7 (1723) | 3.1 (59) |
| Being from an ethnic minority | 0.1 (2) | 5.6. (108) | 88.9 (1707) | 5.4 (104) |
| Poor housing | 2.1 (41) | 17.2 (331) | 73.6 (1414) | 7.1 (136) |
| Lower income | 2.4 (45) | 23.8 (458) | 65.5 (1258) | 8.4 (161) |
| Vitamin D deficiency | 4.2 (81) | 16.2 (312) | 60.9 (1170) | 18.7 (359) |
| **Health Behaviours** | | | | |
| Smoking cigarettes | 6.0 (115) | 12.5 (240) | 74.4 (1430) | 7.1 (136) |
| Eating unhealthy foods | 1.5 (30) | 23.4 (450) | 64.2 (1234) | 10.8 (207) |
| Using e-cigarettes (vaping) | 3.4 (65) | 27.0 (518) | 49.3 (948) | 20.3 (390) |
| Drinking alcohol | 2.4 (46) | 41.0 (789) | 39.2 (753) | 17.4 (334) |
| Using Nicotine Replacement Therapy (e.g. nicotine gum, patch) | 10.7 (206) | 46.7 (897) | 13.1 (252) | 29.5 (567) |
| Regular physical activity | 64.9 (1347) | 27.6 (531) | 2.2 (43) | 5.3 (101) |
| Spending time in the sun | 49.8 (958) | 33.6 (646) | 1.7 (33) | 14.8 (285) |

**Table 3:** Concurrent engagement with health behaviours and its association with classifying these health behaviours as increasing the risk, decreasing the risk, and having no impact for severe Covid-19 symptoms (results from chi-square)

| | | **Decrease risk vs all other** | **No impact vs all other** | **Increase risk vs all other** | **Don't know** | ***p*** |
|---|---|---|---|---|---|---|
| **Potential risk factors for severe Covid-19** | **Predictors: Relevant health behaviour concurrent to assessment of risks** | **% (weighted n)** | | | | |
| Smoking cigarettes | Tobacco smoking | 10.1 (36) | 22.6 (81) | 57.8 (207) | 9.5 (34) | <0.001 |
| | Non-use | 5.1 (79) | 10.2 (159) | 78.2 (1223) | 6.6 (103) | |
| Using e-cigarettes (vaping) | E-cigarette use | 11.7 (33) | 50.4 (142) | 20.2 (57) | 17.7 (50) | <0.001 |
| | Non-use | 2.0 (32) | 23.0 (377) | 54.3 (891) | 20.7 (340) | |
| Using Nicotine Replacement Therapy | Tobacco smoking | 19.6 (70) | 49.0 (175) | 8.7 (31) | 22.7 (81) | <0.001 |
| | Non-use | 8.7 (136) | 46.1 (721) | 14.1 (221) | 31.0 (485) | |
| | E-cigarette use | 17.7 (50) | 60.8 (172) | 5.3 (15) | 16.3 (46) | <0.001 |
| | Non-use | 9.6 (157) | 44.2 (725) | 14.5 (237) | 31.7 (520) | |
| Drinking alcohol | >14 alcohol units/week in the past month | 4.6 (21) | 49.7 (227) | 33.0 (151) | 12.7 (58) | <0.001 |
| | ≤14 alcohol units/week in the past month | 1.3 (13) | 40.7 (419) | 39.8 (410) | 18.3 (188) | |
| | 0 alcohol units/week in the past month | 2.5 (11) | 32.9 (143) | 44.2 (192) | 20.3 (88) | |
| Regular physical activity | Meets no requirements (ref) | 55.8 (509) | 34.5 (315) | 2.6 (24) | 7.1 (65) | <0.001 |
| | Meets MSA or MVPA | 71.1 (498) | 22.7 (159) | 2.0 (14) | 4.1 (29) | |
| | Meets MSA and MVPA | 77.7 (240) | 18.4 (57) | 1.6 (5) | 2.3 (7) | |
| Eating unhealthy foods | Fruit & veg a few times/day | 1.5 (16) | 19.1 (206) | 69.4 (750) | 10.8 (108) | <0.001 |
| | Not | 1.5 (13) | 29.1 (245) | 57.6 (484) | 11.8 (99) | |

**Table 4:** Concurrent engagement with health behaviours as an independent predictor of classifying these health behaviours as increasing the risk, decreasing the risk, and having no impact for severe Covid-19 symptoms (each cells presents results from a separate unadjusted and fully adjusted logistic regression models).

| | | **Decrease risk vs all other** | **No impact vs all other** | **Increase risk vs all other** |
|---|---|---|---|---|
| **Potential risk factors for severe Covid-19** | **Correlates: Relevant health behaviour concurrent to assessment of risks** | **aOR[1], 95% CI** | | |
| Smoking cigarettes | Tobacco smoking (vs not) | **2.26 (1.39-3.37)*** | **1.98 (1.42-2.76)*** | **.43 (.32.-56)*** |
| Using e-cigarettes (vaping) | E-cigarette use (vs not) | **5.80 (3.25-10.34)*** | **2.63 (1.96-3.50)*** | **.25 (.18-.35)*** |
| Using Nicotine Replacement Therapy | Tobacco smoking (vs not) | **2.64 (1.85-3.77)*** | .95 (.73-1.22) | .63 (.41-.97) |
| | E-cigarette us (vs not) | **1.74 (1.18-2.56)*u** | **1.80 (1.36-2.38)*** | **.34 (.20-.60)*** |
| Drinking alcohol | 0 alcohol units/week | -[a] | 1.0 | 1.0 |
| | ≤14 alcohol units/week | -[a] | **1.58 (1.23-2.03)** | **.72 (.57-.92)** |
| | >14 alcohol units/week | -[a] | **1.75 (1.31-2.33)** | .70 (.53-.93) |
| Regular physical activity | Meets no requirements (ref) | 1.0 | 1.0 | -[a] |
| | Meets MSA or MVPA | **1.72 (1.38-2.16)*** | **.62 (.49-.79)*** | -[a] |
| | Meets MSA and MVPA | **2.42 (1.75-3.34)*** | **.50 (.35-.70)*** | -[a] |
| Eating unhealthy foods | Fruit & veg a few times/day (vs not) | -[a] | **.71 (.56-.90)*u** | **1.37 (1.12-1.69)*u** |

1=models were run on weighted data and were fully adjusted for (* assessed at 1-month follow-up): age, gender, post-16 education, income, house tenure, ethnicity, BMI (categorical), any health condition, living with a vulnerable person, working as a key worker, employment status*, self-perceived risk of Covid-19 to oneself (as Minimal/no risk vs all other), tobacco smoking, vaping, meeting WHO recommendations for physical activity (meeting none, meeting either strength or aerobic activity, meeting both), diet (binary: eating fruit and veg a few times per day (vs not); time of follow-up (3 levels); *(and bold) marks results that were significant following BH correction (p-value<.015); ' -[a] ' signifies that this model was not run due to low prevalence of endorsement of this answer option; u=not significant in unweighted analysis.

References

Aghababaeian, H., Hamdanieh, L., & Ostadtaghizadeh, A. (2020). Alcohol intake in an attempt to fight COVID-19: A medical myth in Iran. *Alcohol, 88*, 29-32. doi: 10.1016/j.alcohol.2020.07.006

ASH. (2020). COVID-19 drives 'astonishing' quit rate among young smokers: Experts ask if trend will survive loosening lockdown. from Retrieved from https://ash.org.uk/media-and-news/press-releases-media-and-news/covidyoungsmokers/

Aveyard, P., Lindson, N., Gao, M., Hartmann-Boyce, J., Smith, M., Young, D., & Gould, D. (2020). Associations between COVID-19 infection, tobacco smoking and nicotine use, common respiratory conditions and inhaled corticosteroids: a prospective QResearch-Case Mix Programme data linkage study January-May 2020. *MedRxiv*. doi: 10.1101/2020.06.05.20116624

Beard, E., Brown, J., Jackson, S. E., West, R., Kock, L., Boniface, S., & Shahab, L. (2020). Independent associations between different measures of socioeconomic position and smoking status: A cross-sectional study of adults in England. *Nicotine Tob Res*. doi: 10.1093/ntr/ntaa030

Benjamini, Y., & Hochberg, Y. (1995). Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society: Series B (Methodological), 57*(1), 289-300. doi: 10.1111/j.2517-6161.1995.tb02031.x

Bottemanne, H., Morlaas, O., Fossati, P., & Schmidt, L. (2020). Does the Coronavirus Epidemic Take Advantage of Human Optimism Bias? *Frontiers in Psychology, 11*, 2001. doi: 10.3389/fpsyg.2020.02001

Bradley, K. A., DeBenedetti, A. F., Volk, R. J., Williams, E. C., Frank, D., & Kivlahan, D. R. (2007). AUDIT-C as a brief screen for alcohol misuse in primary care. *Alcohol Clin Exp Res, 31*(7), 1208-1217. doi: 10.1111/j.1530-0277.2007.00403.x

Branstrom, R., Kristjansson, S., & Ullen, H. (2006). Risk perception, optimistic bias, and readiness to change sun related behaviour. *Eur J Public Health, 16*(5), 492-497. doi: 10.1093/eurpub/cki193

Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: the example of vaccination. *Health Psychol, 26*(2), 136-145. doi: 10.1037/0278-6133.26.2.136

Butler, M. J., & Barrientos, R. M. (2020). The impact of nutrition on COVID-19 susceptibility and long-term consequences. *Brain, Behavior, and Immunity, 87*, 53-54. doi: 10.1016/j.bbi.2020.04.040

CDC. (2020). People with Certain Medical Conditions. from Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fneed-extra-precautions%2Fgroups-at-higher-risk.html

Changeux, J.-P., Amoura, Z., Rey, F., & Miyara, M. (2020). A nicotinic hypothesis for Covid-19 with preventive and therapeutic implications. *Qeios*. doi: 10.32388/fxgqsb

Dalton, N. (2020). Coronavirus: France limits nicotine patch sales after researchers say product may protect against disease. . from Retrieved from: https://www.independent.co.uk/news/world/europe/coronavirus-france-nicotine-patch-gum-research-covid-19-a9484696.html

Dillard, A. J., McCaul, K. D., & Klein, W. M. (2006). Unrealistic optimism in smokers: implications for smoking myth endorsement and self-protective motivation. *J Health Commun, 11 Suppl 1*, 93-102. doi: 10.1080/10810730600637343

Farsalinos, K., Barbouni, A., & Niaura, R. (2020). Systematic review of the prevalence of current smoking among hospitalized COVID-19 patients in China: could nicotine be a therapeutic option? *Internal and Emergency Medicine, 15*(5), 845-852. doi: 10.1007/s11739-020-02355-7

Farsalinos, K., Niaura, R., Le Houezec, J., Barbouni, A., Tsatsakis, A., Kouretas, D., . . . Poulas, K. (2020). Editorial: Nicotine and SARS-CoV-2: COVID-19 may be a disease of the nicotinic cholinergic system. *Toxicol Rep, 7*, 658-663. doi: 10.1016/j.toxrep.2020.04.012

Ferrer, R., & Klein, W. M. (2015). Risk perceptions and health behavior. *Curr Opin Psychol, 5*, 85-89. doi: 10.1016/j.copsyc.2015.03.012

Gawronski, B. (2012). Back to the Future of Dissonance Theory: Cognitive Consistency as a Core Motive. *Social Cognition, 30*(6), 652-668. doi: 10.1521/soco.2012.30.6.652

Grant, W. B., Lahore, H., McDonnell, S. L., Baggerly, C. A., French, C. B., Aliano, J. L., & Bhattoa, H. P. (2020). Evidence that Vitamin D Supplementation Could Reduce Risk of Influenza and COVID-19 Infections and Deaths. *Nutrients, 12*(4). doi: 10.3390/nu12040988

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform, 42*(2), 377-381. doi: 10.1016/j.jbi.2008.08.010

Hartmann-Boyce, J., & Lindson, N. (2020). The role of nicotine in COVID-19 infection., from Accessed 01 Sept 2020 from: https://www.cebm.net/covid-19/nicotine-replacement-therapy/#:~:text=Nicotine%20and%20cigarette%20smoke%20decrease,inhibit%20hyperinflammation%20and%20platelet%20reactivity.

Ioannou, G. N., Locke, E., Green, P., Berry, K., O'Hare, A. M., Shah, J. A., . . . Fan, V. S. (2020). Risk Factors for Hospitalization, Mechanical Ventilation, or Death Among 10131 US Veterans With SARS-CoV-2 Infection. *JAMA Netw Open, 3*(9), e2022310. doi: 10.1001/jamanetworkopen.2020.22310

Katapodi, M. C., Lee, K. A., Facione, N. C., & Dodd, M. J. (2004). Predictors of perceived breast cancer risk and the relation between perceived risk and breast cancer screening: a meta-analytic review. *Prev Med, 38*(4), 388-402. doi: 10.1016/j.ypmed.2003.11.012

King, G., & Zeng, L. (2017). Logistic Regression in Rare Events Data. *Political Analysis, 9*(2), 137-163. doi: 10.1093/oxfordjournals.pan.a004868

Michie, S., van Stralen, M. M., & West, R. (2011a). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science, 6*, 42. doi: DOI:10.1186/1748-5908-6-42

Michie, S., van Stralen, M. M., & West, R. (2011b). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci, 6*, 42. doi: 10.1186/1748-5908-6-42

Miyara, M., Tubach, F., Pourcher, V., Morelot-Panzini, C., Pernet, J., Haroche, J., . . . Amoura, Z. (2020). Low incidence of daily active tobacco smoking in patients with symptomatic COVID-19. *Qeios*. doi: 10.32388/wpp19w.3

NHS. (2020). Who's at higher risk from coronavirus. .

Nickerson, R. S. (1998). Confirmation Bias: A Ubiquitous Phenomenon in Many Guises. *Review of General Psychology, 2*(2), 175-220. doi: 10.1037/1089-2680.2.2.175

Office for National Statistics. (2020a). Average household income, UK: financial year ending 2020 (provisional). from Accessed on 30th Nov 2020 from: https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/incomeandwealth/bulletins/householddisposableincomeandinequality/financialyearending2020provisional#:~:text=More%20information%20about%20this%20process,30%2C100)%20shown%20in%20Figure%201.

Office for National Statistics. (2020b). Estimates of the population for the UK, England and Wales, Scotland and Northern Ireland. from Retrieved from: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland

Presson, P. K., & Benassi, V. A. (1996). Illusion of control: A meta-analytic review. *Journal of social behavior and personality, 11*(3).

Rhodes, J. M., Subramanian, S., Laird, E., & Kenny, R. A. (2020). Editorial: low population mortality from COVID-19 in countries south of latitude 35 degrees North supports vitamin D as a factor determining severity. *Aliment Pharmacol Ther, 51*(12), 1434-1437. doi: 10.1111/apt.15777

Rogers, R. W. (1975). A Protection Motivation Theory of Fear Appeals and Attitude Change1. *Journal of Psychology, 91*(1), 93-114. doi: 10.1080/00223980.1975.9915803

Sallis, J. F., Adlakha, D., Oyeyemi, A., & Salvo, D. (2020). An international physical activity and public health research agenda to inform coronavirus disease-2019 policies and practices. *J Sport Health Sci, 9*(4), 328-334. doi: 10.1016/j.jshs.2020.05.005

Shahab, L., McGowan, J. A., Waller, J., & Smith, S. G. (2018). Prevalence of beliefs about actual and mythical causes of cancer and their association with socio-demographic and health-related characteristics:

Findings from a cross-sectional survey in England. *Eur J Cancer, 103*, 308-316. doi: 10.1016/j.ejca.2018.03.029

Sharot, T. (2011). The optimism bias. *Curr Biol, 21*(23), R941-945. doi: 10.1016/j.cub.2011.10.030

Shokoohi, M., Nasiri, N., Sharifi, H., Baral, S., & Stranges, S. (2020). A syndemic of COVID-19 and methanol poisoning in Iran: Time for Iran to consider alcohol use as a public health challenge? *Alcohol, 87*, 25-27. doi: 10.1016/j.alcohol.2020.05.006

Simons, D., Shahab, L., Brown, J., & Perski, O. (2020). The association of smoking status with SARS-CoV-2 infection, hospitalisation and mortality from COVID-19: A living rapid evidence review with Bayesian meta-analyses (version 9). *Qeios*. doi: 10.32388/ujr2aw.10

Tattan-Birch, H., Perski, O., Jackson, S., Shahab, L., West, R., & Brown, J. (2020). COVID-19, smoking, vaping and quitting: a representative population survey in England. *Addiction*. doi: 10.1111/add.15251

The OpenSAFELY Collaborative, Williamson, E., Walker, A. J., Bhaskaran, K. J., Bacon, S., Bates, C., . . . Goldacre, B. (2020). OpenSAFELY: factors associated with Covid-19-related hospital death in the linked electronic health records of 17 million adult NHS patients. *MedRxiv*. doi: 10.1101/2020.05.06.20092999

Ward, H., Atchison, C. J., Whitaker, M., Ainslie, K. E. C., Elliott, J., Okell, L. C., . . . Elliott, P. (2020). Antibody prevalence for SARS-CoV-2 in England following first peak of the pandemic: REACT2 study in 100,000 adults. *MedRxiv*. doi: 10.1101/2020.08.12.20173690

Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39*(5), 806-820. doi: 10.1037/0022-3514.39.5.806

WHO. (2020). WHO Coronavirus Disease (COVID-19) Dashboard. from Accesed on 14th December 2020 from: https://covid19.who.int/

Wise, T., Zbozinek, T. D., Michelini, G., Hagan, C. C., & Mobbs, D. (2020). Changes in risk perception and self-reported protective behaviour during the first week of the COVID-19 pandemic in the United States. *R Soc Open Sci, 7*(9), 200742. doi: 10.1098/rsos.200742

Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs,, 59*(4), 329-349.