COVID-19: the relationship between perceptions of risk and behaviours during lockdown

Richard Brown[1], Lynne Coventry[1] and Gillian Pepper[1]

[1] Psychology Department at Northumbria University

Abstract

Background

Understanding COVID-19 risk perceptions and their impact on behaviour can improve the effectiveness of public health strategies in the future. Prior evidence suggests that, when people perceive uncontrollable risks to their health, they are less likely to make efforts to protect their health in those ways which they can control (e.g. through diet, exercise, and limiting alcohol intake). It is therefore important to understand the extent to which the threat of COVID-19 is perceived to be an uncontrollable risk, and to assess whether this perceived risk is associated with differences in health behaviour.

Methods

We surveyed a nationally representative sample of 496 participants, shortly after the peak of the pandemic in the UK. We collected data to assess people's perceptions of COVID-19-related risk, and how these perceptions were associated with behaviours. We examined self-reported adherence to behaviours recommended by the UK Government and National Health Service to prevent the spread of the virus, as well as more general health behaviours. We predicted that increased perceived extrinsic mortality risk (the portion of a person's mortality risk which they perceive to be uncontrollable) would disincentivise healthy behaviour.

Results

Perceived threat to life was found to be the most consistent predictor of reported adherence to measures designed to prevent the spread of infection. Perceived extrinsic mortality risk was found to have increased due to the pandemic, and was also associated with lower reported adherence to Government advice on diet and physical activity, as well as smoking.

Conclusions

Our findings suggest that promoting a message that highlights threat to life may be effective in raising levels of adherence to measures of infection control, but may also have unintended

consequences, leading to a reduction in health-promoting behaviours. We suggest that messages that highlight threat to life should be accompanied by statements of efficacy, and that messages evoking feelings of concern for others may also be effective in promoting compliance with anti-infection measures.

1. Introduction

Individual perceptions of risk are often inaccurate when compared to the best available objective measures of risk (Leventhal, Kelly & Leventhal, 1999). Inconsistencies between actual and perceived risk are of concern as individual perceptions of risk are important motivators of action and are key for determining health behaviours (Ferrer & Klein, 2015; Leventhal et al., 1999). When forming perceptions of mortality risk, we tend to underestimate common causes of death and overestimate novel causes of death (Frost, Frank & Maibach, 1997). For example, there is a tendency to perceive the likelihood of ‘sensational risks’, such as being involved in an air crash, as higher than the actual risk, whereas perceptions of risk regarding common risks, such as being involved in a car accident, are lower than the objective risk (Pligt, 1998).

A perceived lack of control over risk can have downstream consequences for behaviour. The Uncontrollable Mortality Risk Hypothesis predicts that people who believe they are more likely to die due to factors beyond their control should be less motivated to engage in healthy behaviours, because they are less likely to live to enjoy the rewards of healthy living. This hypothesis has been supported by studies that show both observational and experimental effects of perceived uncontrollable (extrinsic) mortality risk on health behaviour (Pepper & Nettle, 2014a; Pepper & Nettle 2014b; Pepper & Nettle 2014c; Pepper & Nettle 2017). Thus, it is important to understand the extent to which the risks of the pandemic are perceived as extrinsic, and to test for associations between perceived extrinsic risks and health behaviour.

In addition to affecting general health behaviours, perceptions of risk may also influence the extent to which people engage with infection prevention behaviours. Compliance with preventative measures designed to prevent the spread of disease has been suggested to be associated with the public’s perception of risk (Brug, Aro & Richardus, 2009). Individual perceptions of personal vulnerability to a specific risk may also play a key role in the behavioural response to risk (Millstein & Halpern-Felsher, 2002).

There have been urgent calls for research into the psychological factors involved in the public response to COVID-19 (Asmundson & Taylor, 2020). The spread of disease is affected by individual behaviour, which in turn is influenced by perceptions of risk (Ibuka, Chapman, Meyers, Li & Galvani, 2010). The pervasiveness of media coverage has also been shown to exacerbate the severity of perceived risk (Young, King, Harper & Humphreys, 2013). Furthermore, new risks are more likely to be perceived as uncontrollable (de Zwart, Veldhuijzen, Richardus & Brug, 2010). We predict that, due to the novelty of COVID-19 and the extensive media coverage, many people may perceive it as being a mortality risk beyond their control, which may have downstream behavioural consequences. More information is needed to understand the relationships between perceptions of risk and health behaviours during the outbreak of COVID-19 (Betsch, Wieler & Habersaat, 2020). To address this, we have examined how risk perceptions were associated with self-reported behaviour during the strictest period of lockdown in the UK. Based on our findings, we make suggestions towards improving the effectiveness of public health strategies in the future.

2. Method

This study was approved by the Department of Psychology Ethics Committee (23857) at Northumbria University. Our measures, predictions and analytical plan are registered with the Open Science Framework [https://osf.io/8jqsn/].

For our study, 514 adults were anonymously surveyed using a Qualtrics questionnaire delivered by the platform Prolific [www.prolific.co], a company that offers a high-quality participant pool of research-participant volunteers, and provided a nationally-representative sample of UK participants. The target sample size of 500 was based on suggested guidelines for conducting surveys in exploratory research (Daniel, 2012).

The survey was launched on 6 May 2020, and closed on 7 May 2020. For context, the largest number of registered deaths in England and Wales occurred during the week ending 17 April 2020 (Office for National Statistics, 2020). However, the UK became the first country in Europe to surpass

30,000 COVID-19 related deaths on 6 May 2020, the day our survey was launched, meaning that the death rate would have been salient in the media at the time ("Coronavirus (COVID-19) in the UK", 2020). Thus, our findings report the perceptions and behaviours of participants after the peak of the pandemic, but still within the strictest period of the UK lockdown (Cabinet Office, 2020a).

We excluded 16 participants from our analysis due to inconsistent survey responses for age and gender on our survey, when compared to the responses on their Prolific profile. Two further participants were excluded as extreme outliers, having reported knowing 200 or more people who had contracted COVID-19. Participants were asked their age, gender, ethnicity, and National Statistics Socio-economic Classification (NS-SEC). Our final sample comprised 496 participants: 254 females and 242 males, aged 19-85 (mean age = 45.95, SD = 15.41). The questionnaire is available as part of our pre-registration on the Open Science Framework [https://osf.io/8jqsn/]. In the same survey, data were also collected on information seeking behaviours and experiences of COVID-19. These findings are reported in “COVID-19 risk perceptions and their associations with related media consumption and personal experiences” (Brown, Coventry & Pepper, 2020).

2.1. Perceptions of risk

Participants provided a measure of perceived extrinsic mortality risk by stating a score for their believed likelihood of living to 81 (the current average UK life expectancy), provided they make the maximum effort to look after their health (on a scale from 0, no chance, to 100, certain). The score was then subtracted from 100: Perceived extrinsic mortality risk is the difference between 100% certainty of living to 81 and the perceived likelihood of living to 81 with maximum health effort (Pepper & Nettle, 2014b). This reflects the ‘extrinsic’ portion of mortality risk, or the portion of risk which the participant believes is beyond their control. Two perceived extrinsic mortality risk scores were recorded. Firstly, a score that takes the effects of the current pandemic into consideration. Secondly, an estimated score for how participants felt they would have responded without the effects of the current pandemic. The difference between these scores was used to determine the influence of the pandemic on perceived extrinsic mortality risk.

Participants also provided a measure of perceived risk of infection by stating a score for their believed likelihood of contracting COVID-19, provided they made the maximum effort to follow what were Government-recommended preventative measures at the time (see below, section 2.2). This was reported, again on a scale from 0 (no chance) to 100 (certain) of being infected. A score for perceived threat to life from COVID-19 was also recorded, again with a scale ranging from 0 (not at all a threat to life), to 100 (absolutely a threat to life). Finally, participants rated their concern and perceived degree of control over preventing the spread of COVID-19 to others, in the event that they become infected. All scores for perceptions of risk were on a scale from 0 to 100.

2.2. Adherence to preventative measures

Participants were asked the degree to which they were adhering to measures designed to prevent the spread of infection during the outbreak of COVID-19. They indicated their adherence by selecting answers on a seven point Likert scale for how often they were following specific measures, ranging from 'never' to 'always'. The questions asked were about adherence to the following six preventative measures, which were recommended by the UK Government and the NHS at the time of conducting the survey:

1. *"Only go outside of your home for food, health reasons or work (but only if you cannot work from home)."*
2. *"If you do go outside of your home, stay 2 metres (6ft) away from other people at all times."*
3. *"Do not go outside of your home to meet others, even friends or family."*
4. *"Wash your hands with soap and water often, making sure to do this for at least 20 seconds."*

5. *"Cover your mouth and nose with a tissue or your sleeve (not your hands) when you cough or sneeze."*
6. *"Do not touch your eyes, nose or mouth if your hands are not clean."*

2.3. General health behaviours

Participants were asked to indicate the degree to which they were adhering to general public health advice recommended by the NHS at the time of the survey. Participants indicated their adherence by selecting answers on a seven-point Likert scale for how often they were following specific recommendations, ranging from 'never' to 'always'. The questions asked were about adherence to the following health advice:

1. *"Eat at least 5 portions of a variety of fruit and vegetables every day."*
2. *"Avoid regularly drinking more than 14 units of alcohol per week."*
   (14 units is equivalent to a bottle and a half of wine or five pints of export-type lager (5% abv) over the course of a week – this applies to both men and women)
3. *"Do at least 150 minutes of moderate intensity activity a week or 75 minutes of vigorous intensity activity a week."*
   (One way to tell if you're working at a moderate intensity level is if you can still talk, but not sing. Vigorous intensity activity makes you breathe hard and fast. If you're working at this level, you will not be able to say more than a few words without pausing for breath)

Participants also answered the question "do you smoke" by selecting an answer on a seven-point Likert scale, ranging from 'never' to 'always'. This measure was reverse scored so that a higher score reflects the degree to which participants were adhering to general public health advice not to smoke.

2.4. Analysis

All statistical analyses were performed using R (R Core Team, 2019). The R script used for data processing and analysis is available as an electronic supplement to this article. The following packages were used for data processing, analysis, and data visualisation: tidyverse (Wickham, 2017), tidyr (Wickham & Henry, 2019), pysch (Revelle, 2018), MASS (Venables & Ripley, 2002), and apaTables (Stanley, 2018).

Our main variables are categorised under 4 key themes: 1) Demographics, 2) Risk perceptions, 3) General health behaviours, and 4) COVID-19 prevention behaviours. For each regression analysis presented, we first ran analyses to look for any demographic differences in perceptions and behaviours. Any significant demographic predictors were then included as control variables in subsequent models. Since compliance with health advice was measured on a 7-point Likert scale, we ran a series of ordinal logistic regression models to assess whether each of the reported behaviours was predicted by perceptions of risk. Continuous predictors in the ordinal models were standardised to aid the comparison of odds ratios. Paired-samples t-tests were used to assess the difference in perceived extrinsic mortality risk with and without taking the risks of the pandemic into account, and the difference between our measures of perceived control over catching COVID-19 and perceived control over spreading it.

3. Results

3.1. Descriptive statistics

Table 1 presents the descriptive statistics for our sample, whose ages ranged from 19-85 (M = 45.95, SD = 15.41).

Table 1. Sample characteristics for age, gender, ethnicity, and occupational class

	Category	**Number** *(N = 496)*	**Percentage of sample**
Age	18-34	137	27.62
	35-49	140	28.23
	50-64	160	32.26
	65+	59	11.90
Gender	Female	254	51.21
	Male	242	48.79
Ethnicity	White	400	80.65
	Asian	42	8.47
	Black	24	4.84
	Mixed	16	3.23
	Other	14	2.82
Occupational class (NS-SEC) *(N = 393)*	1.1 Large employers and higher managerial and administrative occupations	11	2.80
	1.2 Higher professional occupations	58	14.76
	2. Lower managerial, administrative and professional occupations	74	18.83
	3. Intermediate occupations	75	19.08
	4. Small employers and own account workers	13	3.31
	5. Lower supervisory and technical occupations	8	2.04
	6. Semi-routine occupations	32	8.14
	7. Routine occupations	25	6.36
	8. Never worked and long-term unemployed	97	25.68

3.2. Perceptions of risk

Table 2 presents the descriptive statistics for all of our measures of perceived COVID-19 related risk.

Table 2. Descriptive statistics for perceptions of COVID-19 related risk

	Mean	**Median**	**SD**	**Min**	**Max**
Perceived risk of infection	25.89	20	21.55	0	100
Perceived threat to life	46.39	49	31.80	0	100
Perceived extrinsic mortality risk with the pandemic	32.73	29	21.07	0	100
Perceived extrinsic mortality risk without the pandemic	28.06	21	20.93	0	100
Perceived extrinsic mortality risk difference	4.68	1	12.12	-80	69
Concern over spreading the infection to others	83.51	92	23.17	0	100
Perceived control over spreading infection to others	63.44	70	26.17	0	100

Number = 496 for all variables. SD = Standard deviation, Min = Minimum, Max = Maximum.

A paired *t*-test showed a significant difference of 4.68% on average between perceived extrinsic mortality risk scores that took the effects of the pandemic into consideration (M = 32.73) and those that estimated the level of perceived risk that would have been experienced without the effects of the pandemic (M = 28.06), $t(495) = 8.60$, $p < .001$. Overall, 54% of our sample reported a difference in perceived extrinsic mortality risk when taking the effects of the pandemic into account. For one third of our sample, there was no difference in perceived risk when taking the effects of the pandemic into consideration compared with not doing so. Just over a third reported an increase of between 1-10%, one fifth reported an increase of over 20% and the remainder of the sample reported a reduction in perceived risk when taking the effects of the pandemic into consideration (see supplement, table S1).

Participants felt more able to control whether they would contract COVID-19 themselves (M = 74.12%) than whether they would spread the infection to others in the event that they became infected (M = 63.44%), $t(495) = 7.05$, $p < .001$.

We predicted that perceived extrinsic mortality risk, accounting for the pandemic, would be affected by a combination of perceived risk of infection and perceived threat to life. Perceived threat to life was predictive of the difference between perceived extrinsic mortality risk scores that took the outbreak of COVID-19 into consideration and scores that did not, $b = .07$, (95% CI = .02, .13), $p < .01$. However, perceived risk of infection was not predictive of this difference (see supplement, table S2).

3.3. General health behaviour during the pandemic

Figure 1 shows the frequencies of the different reported levels of compliance with the UK Government’s recommendations regarding diet, alcohol consumption, physical activity and smoking during the outbreak of COVID-19.

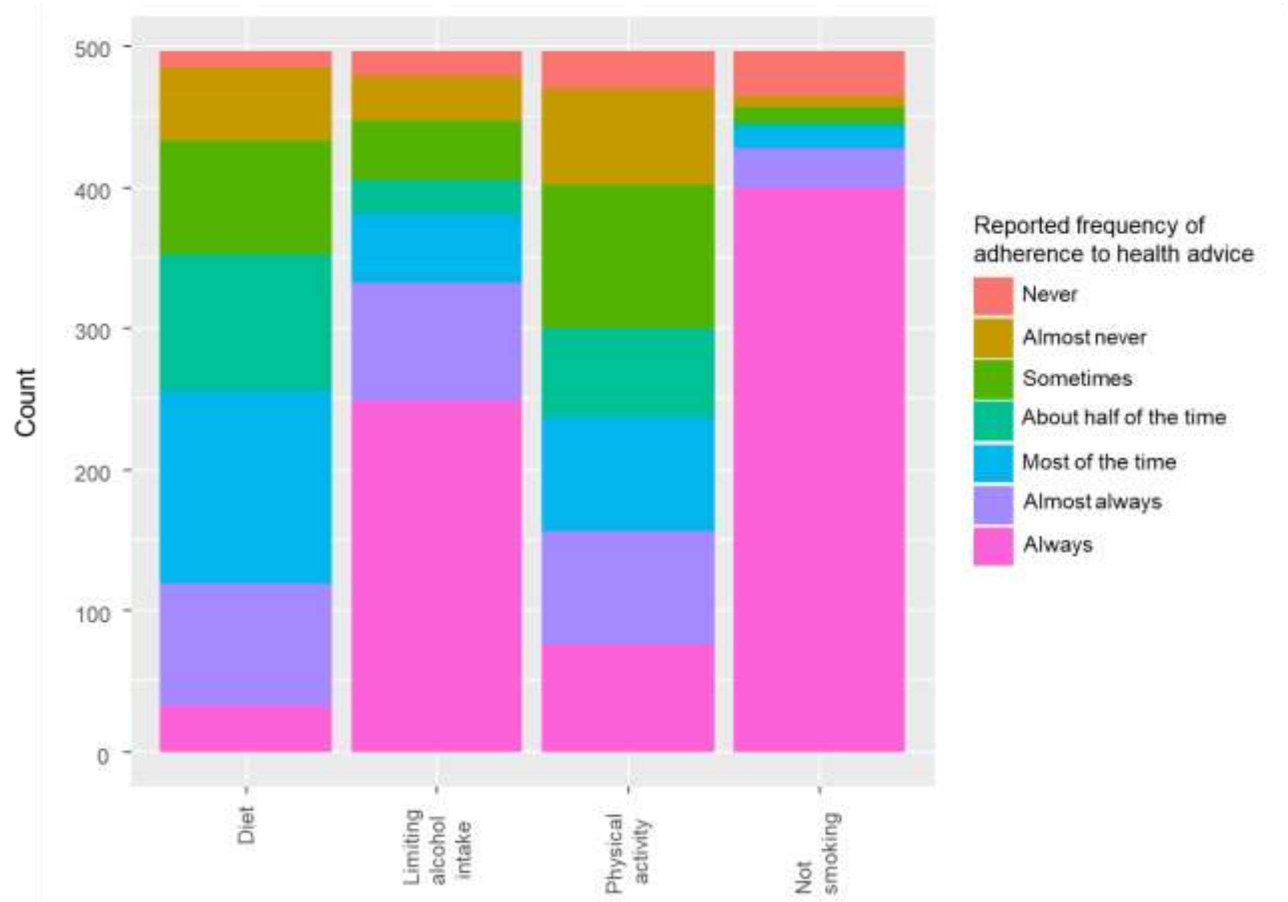

Figure 1. Frequency of reported compliance with UK Government health recommendations

Greater perceived extrinsic mortality risk when taking the pandemic into account was associated with lower adherence to dietary advice (β = -.29, s.e. = .08, OR = 0.75, 95% CIs = 0.63, 0.88; see figure 2). Controlling for the known effect of gender (β = 0.40, s.e. = 0.16, OR = 1.49, 95% CIs =1.09, 2.05), perceived extrinsic mortality risk was also associated with lower reported adherence to physical activity guidelines (β = -.32, s.e. = .09, OR = 0.72, 95% CIs = 0.61, 0.86; see figure 3), and with greater reported frequency of smoking (β = -0.30, s.e. = 0.11, OR = 0.74, 95% CIs =0.59, 0.93; see figure 4), even when controlling for the effect of socioeconomic status (NS-SEC, β = - 0.26, s.e. = 0.12, OR = 0.77, 95% CIs = 0.60, 0.98).

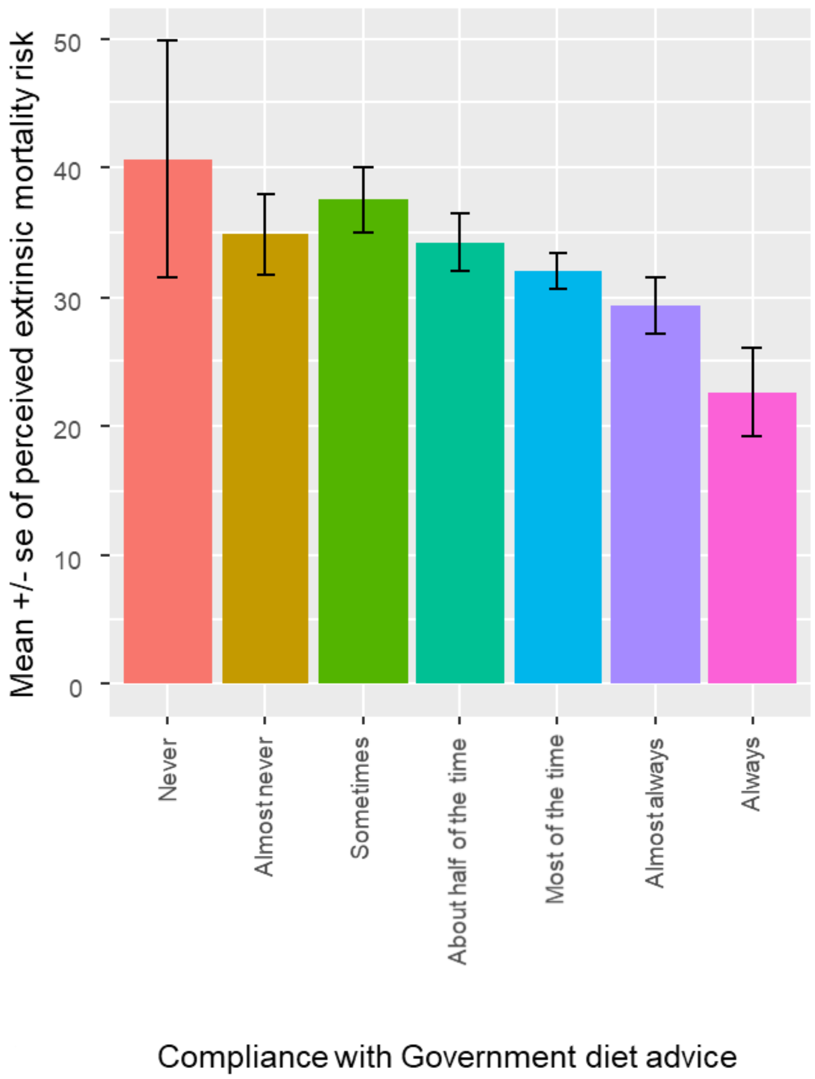

Figure 2. Association between perceived extrinsic mortality risk, taking the pandemic into account, and reported adherence to dietary recommendations

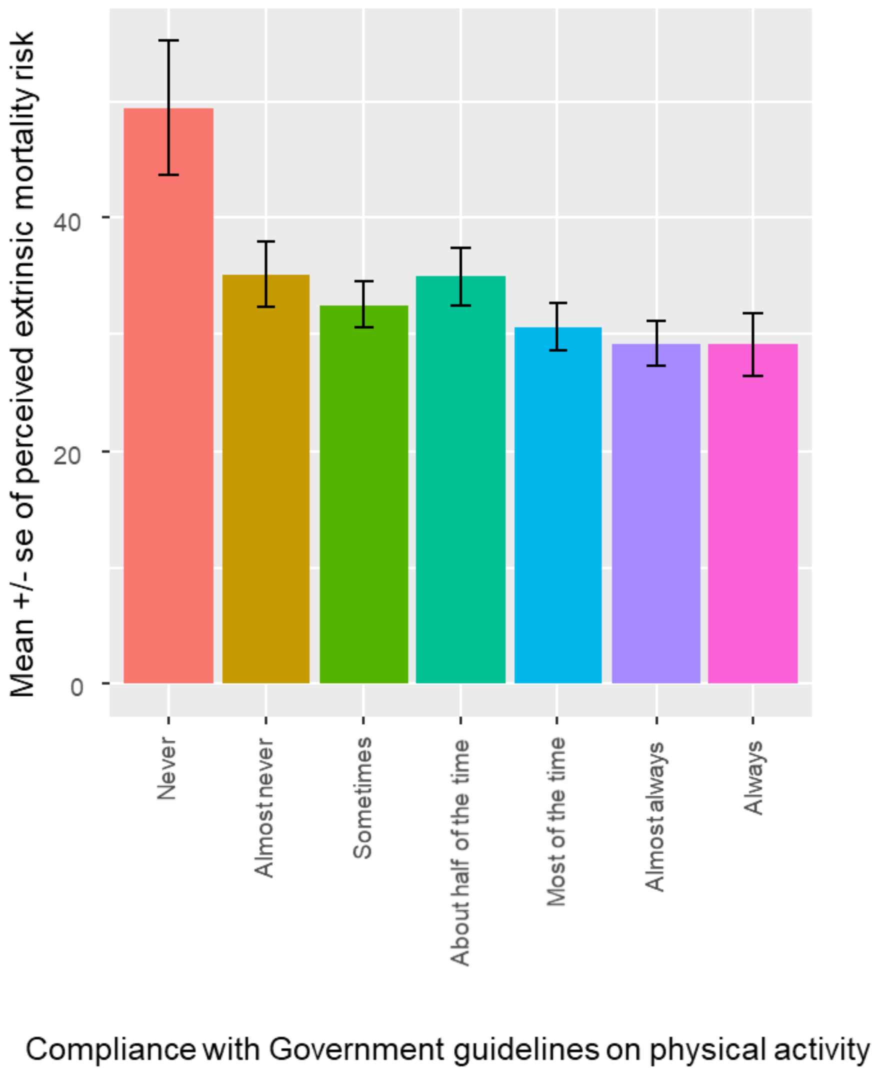

Figure 3. Association between perceived extrinsic mortality risk, taking the pandemic into account, and adherence to physical activity guidelines

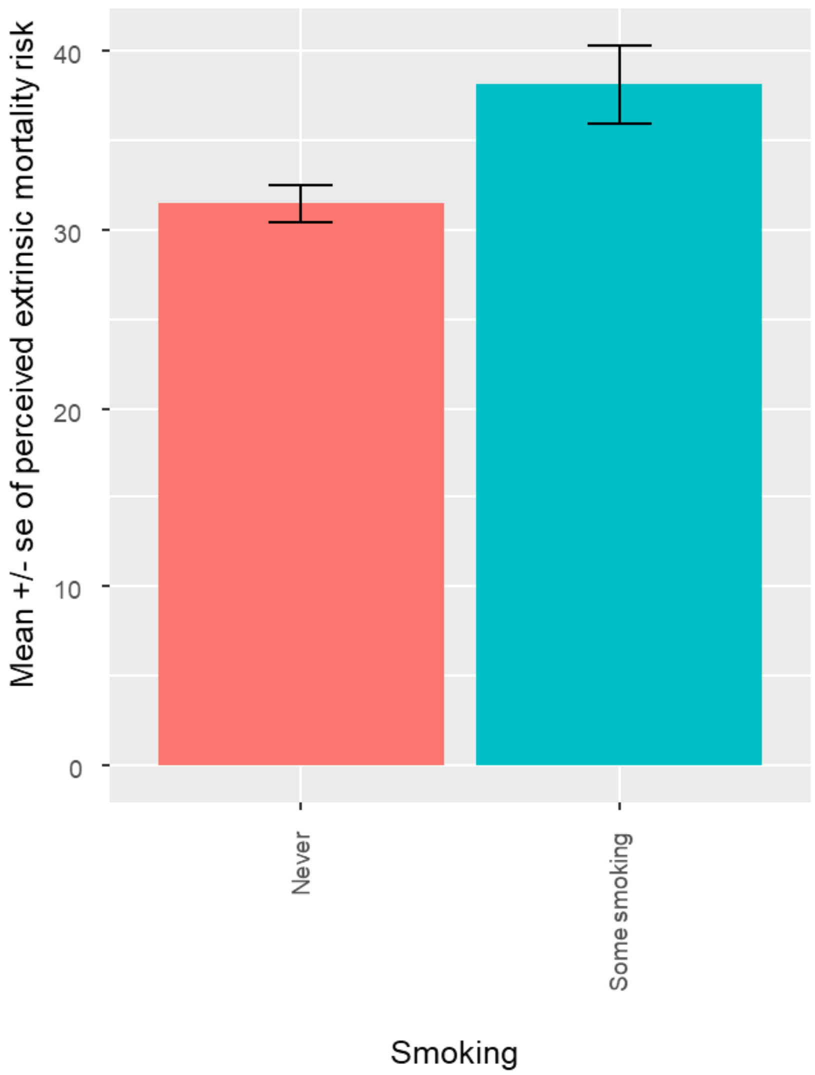

Figure 4. Association between perceived extrinsic mortality risk, taking the pandemic into account, and frequency of smoking

Perceived threat to life was also associated with lower adherence to physical activity guidelines (β = -.18, s.e. = .09, OR = 0.83, 95% CIs = 0.70, 1.00).

3.4. Adherence to preventative measures

The median reported adherence to government measures designed to prevent the spread of COVID-19 infection was “almost always”, with the exception of avoiding touching one’s eyes, nose or mouth with unclean hands, which, on average, participants only reported adhering to “most of the time” (figure 5). 74.4% of our sample reported always adhering to advice not to meet others outside of the home. Similarly, 65.12% reported always adhering to advice to stay at home. However, only

23.59% reported always adhering to advice to not touch one’s face with unclean hands (see supplement, table S4).

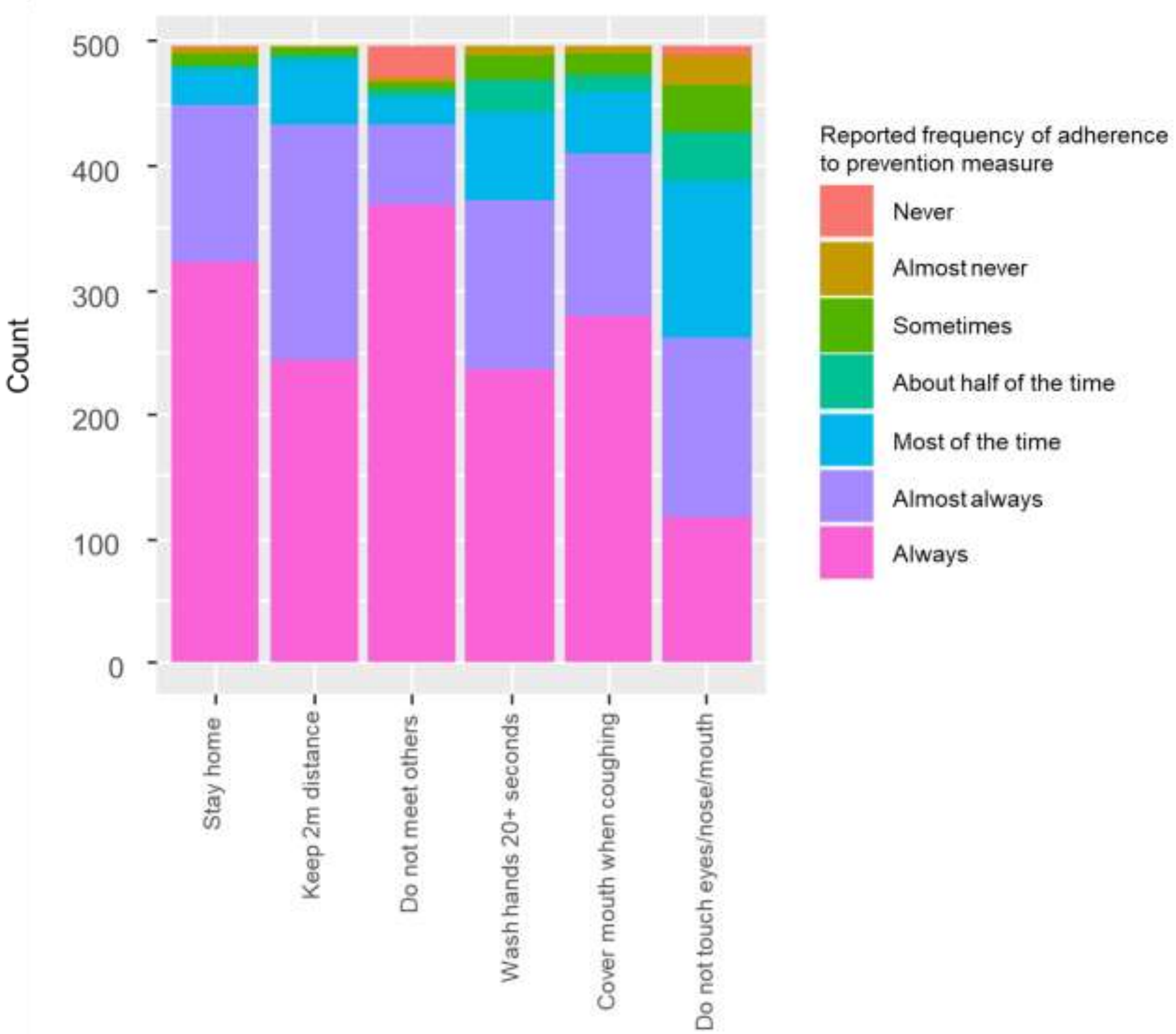

Figure 5. Frequency of adherence to UK Government preventative measures for COVID-19

Our demographic predictors did not predict adherence to COVID-19 advice to stay at home, stay 2m from others when out of the home, or avoid meeting others. However being male was predictive of lower levels of adherence to preventative hygiene measures: handwashing (β = -.69, s.e. = .19, OR = 0.50, 95% CIs = 0.34, 0.73), covering one’s mouth when coughing (β = -.60, s.e. = .20, OR = 0.55, 95% CIs = 0.37, 0.81) and not touching one’s face with unclean hands (β = -.89, s.e. = .19, OR =0.41 , 95% CIs = 0.28, 0.59).

Perceived threat to life was positively associated with adherence to 5 out of 6 preventative measures (the exception being not meeting others outside of the home) and concern about spreading infection to others was associated with 4 out of 6 preventative measures (the exceptions being keeping a 2m distance from others and not touching one's face; see table 3).

Table 3. Results from ordinal logistic regression analyses showing predictors of adherence to infection prevention measures

Outcome	**Stay home**		**Keep 2m distance**		**Do not meet others**		**Wash hands 20+ seconds**		**Cover mouth when coughing**		**Do not touch eyes/nose/mouth**	
	B (s.e.)	OR (CIs)	B (s.e.)	OR (CIs)	B (s.e.)	OR (CIs)	B (s.e.)	OR (CIs)	B (s.e.)	OR (CIs)	B (s.e.)	OR (CIs)
Predictor												
Perceived threat to life	0.39* (0.11)	1.48* (1.20, 1.83)	0.40* (0.10)	1.49* (1.23, 1.80)	0.15 (0.11)	1.16 (0.93, 1.46)	0.45* (0.09)	1.57* (1.31, 1.90)	0.25* (0.10)	1.29* (1.06, 1.56)	0.47* (0.09)	1.61* (1.34, 1.92)
Concern about spreading infection	0.25* (0.09)	1.29* (1.08, 1.54)	0.18 (0.09)	1.20 (1.00, 1.43)	0.21* (0.10)	1.23* (1.01, 1.49)	0.21* (0.09)	1.24* (1.04, 1.47)	0.19* (0.09)	1.21* (1.02, 1.44)	-0.01 (0.08)	0.99 (0.84, 1.16)
Perceived risk of infection	-0.27* (0.09)	0.77* (0.64, 0.92)	-0.18* (0.09)	0.83* (0.70, 0.99)	-0.19 (0.10)	0.83 (0.68, 1.01)	-0.04 (0.09)	0.96 (0.81, 1.14)	0.01 (0.09)	1.01 (0.85, 1.21)	0.02 (0.08)	1.02 (0.87, 1.21)
Perceived control over spreading infection	0.16 (0.10)	1.29 (1.08, 1.54)	0.05 (0.09)	1.05 (0.88, 1.25)	0.07 (0.11)	1.08 (0.87, 1.32)	-0.00 (0.09)	1.00 (0.84, 1.18)	0.17 (0.09)	1.19 (1.00, 1.42)	0.27* (0.08)	1.31* (1.11, 1.54)
Perceived extrinsic mortality risk (with pandemic)	0.04 (0.10)	1.04 (0.86, 1.27)	-0.06 (0.09)	0.94 (0.77, 1.12)	0.02 (0.11)	1.02 (0.83, 1.27)	-0.17 (0.09)	0.85 (0.71, 1.00)	-0.07 (0.09)	0.94 (0.78, 1.11)	-0.12 (0.08)	0.86 (0.75, 1.04)
Sex (male)	NA		NA		NA		-0.69* (0.19)	0.50* (0.34, 0.73)	-0.60* (0.20)	0.55* (0.37, 0.81)	-0.89* (0.19)	0.41* (0.28, 0.59)

*Each outcome was modelled separately. OR = Odds ratio, CI = 95% Confidence interval, *statistically significant (t>2), NA = not applicable because sex was only included where it showed effects in prior demographic models.*

4. Discussion

This study measured perceptions of COVID-19 related risk, and explored the impact of these on both general health behaviours and adherence to measures designed to prevent the spread of infection. Our findings reflect the experience of participants after the peak of the pandemic, but still within the strictest period of the UK lockdown (Cabinet Office, 2020a). As predicted, we found that perceptions of risk were associated with both general health behaviours and levels of adherence to COVID-19 prevention measures.

4.1. Perceptions of risk

Perceived extrinsic mortality risk scores that took the effects of the pandemic into consideration were, on average, 5% higher than those that did not. The extent to which COVID-19 is perceived as an extrinsic mortality risk varied across our sample, however the average response was a small increase in perceived risk when taking the pandemic into consideration. The Uncontrollable Mortality Risk Hypothesis predicts that people with increased perceived extrinsic mortality risk are likely to be less motivated to engage in positive health behaviours (Pepper & Nettle, 2014a), and this prediction was supported by our data. Though we lack longitudinal data to allow us to assess the true extent to which the pandemic has affected health behaviour, our results suggest that the small increase in perceived extrinsic mortality risk which was generated by the pandemic may have disincentivised health behaviours. We found that perceived threat to life, but not perceived risk of infection, was predictive of this pandemic-related increase in perceived extrinsic mortality risk.

4.2. General health behaviour

On average, our sample reported "almost always" adhering to health advice concerning alcohol consumption during the pandemic, following dietary advice "most of the time" and meeting recommended levels of physical activity "about half of the time". Furthermore, 81% of our sample reported that they never smoked.

Greater perceived extrinsic mortality risk was associated with lower levels of adherence to dietary advice and to recommended levels of physical activity. Higher perceived extrinsic mortality risk was also associated with lower incidence of not smoking. This provides additional support for the Uncontrollable Mortality Risk Hypothesis which predicts that people who believe they are more likely to die due to factors beyond their control should be less motivated to engage in positive health behaviours (Pepper & Nettle, 2014a, 2014b). Although we don't have the longitudinal data needed to demonstrate changes in behaviour as a result of the pandemic, this result suggests that, those who are experiencing higher levels of perceived extrinsic mortality risk during the pandemic may be less likely to engage in positive health behaviours, such as a good diet and physical activity. This is worrying, given that an unhealthy diet may lead to worse health outcomes regarding the susceptibility to, recovery from and long term effects of COVID-19 (Butler & Barrientos, 2020). Lower levels of physical activity during the pandemic may also decrease the ability to resist viral infection and contribute towards the risk of long term negative health outcomes (Woods et al., 2020). This suggests that those who are experiencing greater perceived extrinsic mortality risk during the pandemic may be more likely to respond in a way which puts them at greater risk in the event that they become infected with COVID-19. The UK Government has recognised the possibility that COVID-19 will continue to circulate in society long-term (Cabinet Office, 2020b). Therefore, it is possible that the effects on perceived extrinsic mortality risk, and associated health behaviours, may not be limited to the current pandemic but could endure over time to reflect the ongoing threat of COVID-19.

Perceived threat to life was also predictive of lower adherence to recommended levels of physical activity. We speculate that this may be because those who consider COVID-19 to pose a greater threat to life are less likely to leave their home to exercise, due to potential exposure to others and increased risk of infection.

It is noted that Government recommendations in response to COVID-19 were focused on social distancing measures (Cabinet Office, 2020a) and did not provide specific health guidance regarding diet, exercise, smoking and alcohol consumption. Our study measured self-reported adherence to general health advice available from the UK Government and NHS at the time the study. Given the discussed associations between general health behaviours and COVID-19 health outcomes, it is possible that the absence of advice about maintaining general health and fitness during lockdown may have impacted on the susceptibility to negative health outcomes of those infected with COVID-19 (Butler & Barrientos, 2020; Woods et al., 2020).

4.3. Adherence to preventative measures

On average, participants reported “almost always” adhering to government measures designed to prevent the spread of COVID-19 infection, with the exception of avoiding touching one’s eyes, nose or mouth, which, on average, participants reported adhering to “most of the time”. This suggests a reasonably high level of overall compliance with the Government’s recommendations in response to the pandemic. However, there were notable differences in degrees of reported compliance, most apparent when comparing genders. Being male was predictive of lower levels of adherence to hygiene measures recommended by the NHS. This finding is consistent with research into gender differences in compliance with measures designed to prevent the spread of infection, in which male healthcare workers are less compliant than their female counterparts (Ward, 2004). A variety of biological, social and occupational explanations have been suggested for explaining gender differences in infection control (Ward, 2004), however a potential mechanism is provided by the construct of disgust. Disgust is thought to have evolved as a disease-avoidance mechanism for protecting us against contracting infectious disease (Oaten et al., 2009). In response to the threat of infection, disgust is associated with promoting hygiene behaviour (Curtis et al., 2011) and men have consistently been found to have lower levels of disgust than women (Skolnick, 2013). Al-Shawaf, Lewis and Buss (2017) put forward various hypotheses for why women may have evolved higher levels of disgust towards pathogens than men, including to avoid transmitting infections to their offspring. They also suggest that lower levels of disgust in males may serve an evolutionary benefit in signalling a strong immune system to facilitate mating, as well as potential benefits for both hunting and warfare. Men may therefore report lower levels of adherence to hygiene measures designed to prevent the spread of infection because they typically experience lower levels of disgust than women.

A range of risk perception variables were predictive of levels of compliance to preventative measures. This provides support for the notion that compliance with measures designed to prevent the spread of disease is associated with the public's perception of risk (Brug et al., 2009). Research during the current pandemic has also found that risk perception is positively correlated with adherence to a variety of preventative measures related to social distancing and hygiene (Dryhurst et al., 2020). The most notable predictor of adherence from our sample was perceived threat to life from COVID-19, which was positively associated with higher levels of compliance with 5 of the 6 preventative measures. This provides some support for the findings of early research into the response to the pandemic in the UK which found that the sole predictor of public health compliance was fear of COVID-19 (Harper et al., 2020). Harper et al. (2020) argued that fear may induce a functional response to the pandemic through increased compliance with health measures. However, given that fear appeals may also increase perceived extrinsic mortality risk, potentially thereby decreasing other health promoting behaviours, we would recommended focusing on approaches that make the threat appear more controllable. Indeed, others have suggested that fear communications are more effective when people believe that they have the capacity to respond to the threat (Peters et al., 2018). A recent meta-analysis of the utility of fear appeals found that their effectiveness increases when accompanied by statements of efficacy (Tannenbaum et al., 2015). Statements of efficacy provide information regarding an individual's ability to effectively respond to a threat, as well as promoting the utility of the proposed response (Mongeau, 2020). In the context of the current pandemic, statements of efficacy may emphasise the utility of proposed COVID-19 prevention measures, as well as highlighting an individual's ability to protect themselves from infection by complying with these measures. Current research into compliance with COVID-19 prevention measures in response to the pandemic has found that feelings of efficacy are effective in motivating compliance (Jørgensen, Bor & Petersen, 2020).

The second most consistent predictor of adherence to preventative measures from our risk perception variables was concern over spreading the infection to others. This measure was associated with 4 out of 6 of the infection control measures suggesting that, in addition to threat to life, individuals are also motivated to comply with public health strategies by their concern for others. This motivation may be especially pertinent to compliance with additional preventative behaviours that are more relevant to preventing the spread of infection than personally avoiding infection, such as mask wearing. Compliance with such measures may rely on a shift in focus from self-protection to more altruistic behaviour (Cheng, Lam & Leung, 2020).

4.4. Limitations

The results of this study are not without limitation. Firstly, we emphasise that all of the behavioural measures are self-reported. It is possible that these self-reported measures have been affected by participant response biases to reflect social norms regarding compliance with public health measures during the pandemic. Further studies may seek to incorporate objective measures of adherence to recommended behaviours.

Additionally, we recognise that during the outbreak of a new viral threat, the public's perceptions of risk and associated behaviours are likely to evolve in response to constantly changing information and policies throughout the course of the outbreak. The data from our sample were captured at a single point in time during the initial lockdown, therefore our findings will not reflect any ongoing changes in perception and behaviour as the pandemic progresses. Further research may collect data at several time points to reflect how perceptions and behaviours vary over time.

Finally, since we don't have longitudinal data, we can't be certain that the perceived extrinsic mortality risk generated by the pandemic has affected health behaviours. We can only establish that 1) perceived extrinsic mortality risk was associated with poorer self-reported compliance with recommended general health behaviours and, 2) that, on average, participants reported greater perceived extrinsic mortality risk when considering the risk of COVID-19 than when they were asked to discount the risks resulting from the pandemic.

5. Conclusion

Our most consistent predictor of compliance with COVID-19 prevention measures, was perceived threat to life. Elevated levels of perceived threat may therefore increase compliance with measures designed to prevent the spread of infection. However, we also found that perceived threat to life was associated with a reduction in physical activity, and was a predictor of increased perceived extrinsic mortality risk, which was broadly associated with lower engagement with health-promoting behaviours. From a public health perspective, this suggests that, promoting a message that highlights threat to life may be effective in raising levels of adherence to measures of infection control but may ultimately lead to a reduction in positive health behaviours, potentially jeopardising the ability of some individuals to effectively respond to viral infection. This conclusion supports previous research into appealing to fear in public health messaging which found that fear and perceived threats to life can produce a complex set of reactions which include both adaptive and maladaptive health behaviours (Arndt, Routledge & Goldenberg, 2006). We suggest that fear communications should be accompanied by statements of efficacy so that the recipients feel more able to control the threat. Concern over spreading infection to others was our second most consistent predictor of compliance. Due to the complex range of behavioural outcomes that feelings of threat to life may induce, public health strategies that seek to evoke feelings of concern for others may be better for promoting compliance with anti-infection measures whilst avoiding unintended consequences.

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Supplement

Table S1. Frequency and percentage of the difference between scores of perceived extrinsic mortality risk that took the effects of the pandemic into consideration compared to those that did not.

Difference between scores	Frequency	Percentage of sample
Decrease in score	63	12.7
No change	165	33.3
1-10% increase	168	33.9
11-20% increase	61	12.3
21-30% increase	27	5.4
31% + increase	12	2.4

n = 496

Table S2. Regression results examining how perceived risk of contracting COVID-19 despite following Government recommendations, and perceived threat to life from COVID-19 predict the portion of perceived extrinsic mortality risk that is due to the pandemic

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	2.28	[-0.51, 5.07]			
Perceived risk of COVID-19 infection	-0.02	[-0.12, 0.07]	.00	[-.00, .00]	
Perceived threat to life	0.07**	[0.02, 0.13]	.02	[-.01, .04]	
Perceived risk of COVID-19 infection: Perceived threat to life	-0.00	[-0.00, 0.00]	.00	[-.00, .01]	
					R^2 = .030** 95% CI[.00,.06]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S3. Means, standard deviations, and correlations for risk perception variables

Variable	*M*	*SD*	1	2	3	4	5	6
1. Perceived risk of COVID-19 infection	25.89	21.55						
2. Perceived threat to life	46.39	31.80	.18**					
3. Perceived extrinsic mortality risk with the pandemic	32.73	21.07	.02	.18**				
4. Perceived extrinsic mortality risk without the pandemic	28.06	20.93	.04	.09*	.83**			
5. Perceived extrinsic mortality risk difference	4.68	12.12	-.03	.16**	.30**	-.28**		
6. Concern over spreading the infection to others	83.51	23.17	.04	.29**	-.03	-.06	.04	
7. Perceived control over spreading infection to others	63.44	26.17	-.01	-.12**	-.15**	-.14**	-.01	.04

*Note. M and SD are used to represent mean and standard deviation, respectively. * indicates p < .05. ** indicates p < .01. n = 496 for all variables.*

Table S4. Frequency of adherence to preventative measures

Preventative measure	Never	Almost never	Sometimes	About half of the time	Most of the time	Almost always	Always
Stay home	1 (0.20%)	4 (0.81%)	10 (2.02%)	5 (1.01%)	27 (5.44%)	126 (25.40%)	323 (65.12%)
Keep 2m distance	0 (0%)	2 (0.40%)	6 (1.21%)	3 (0.60%)	52 (10.48%)	189 (38.10%)	244 (49.19%)
Do not meet others	24 (4.84%)	5 (1.01%)	6 (1.21%)	5 (1.01%)	23 (4.64%)	64 (12.90%)	369 (74.40%)
Wash hands 20+ seconds	0 (0%)	7 (1.41%)	20 (4.03%)	25 (5.04%)	71 (14.31%)	137 (27.62%)	236 (47.58%)
Cover mouth when coughing	0 (0%)	6 (1.21%)	17 (3.43%)	13 (2.62%)	50 (10.08%)	131 (26.41%)	279 (56.25%)
Do not touch eyes/nose/mouth	8 (1.61%)	22 (4.44 %)	39 (7.86%)	38 (7.66%)	127 (25.60%)	145 (29.23%)	117 (23.59%)

Number = 496 for all variables.

Table S5. Regression results assessing how age, gender, and simplified NS-SEC predict people's perceived risk of contracting COVID-19 despite following Government recommendations

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	28.67**	[19.58, 37.76]			
Age	-0.01	[-0.18, 0.16]	.00	[-.00, .00]	
Gender (Male)	-1.20	[-5.69, 3.29]	.00	[-.00, .01]	
Simplified NS-SEC	-0.26	[-1.11, 0.59]	.00	[-.01, .01]	
					R^2 = .002 95% CI[.00,.01]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S6. Regression results assessing how age, gender, and simplified NS-SEC predict people's perceived threat to life from COVID-19

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	34.01**	[21.30, 46.72]			
Age	0.24*	[0.01, 0.48]	.01	[-.01, .03]	
Gender (Male)	-10.60**	[-16.87, -4.32]	.03	[-.00, .06]	
Simplified NS-SEC	1.03	[-0.16, 2.22]	.01	[-.01, .02]	
					R^2 = .048** 95% CI[.01,.09]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S7. Regression results assessing how age, gender, and simplified NS-SEC predict people's perceived extrinsic mortality risk with the pandemic

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	25.31**	[16.29, 34.32]			
Age	0.07	[-0.10, 0.24]	.00	[-.01, .01]	
Gender (Male)	3.28	[-1.17, 7.73]	.01	[-.01, .02]	
Simplified NS-SEC	0.71	[-0.13, 1.55]	.01	[-.01, .02]	
					R^2 = .012 95% CI[.00,.04]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S8. Regression results assessing how age, gender, and simplified NS-SEC predict people's perceived extrinsic mortality risk when asked to think about what it would be without the pandemic

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	18.36**	[9.42, 27.31]			
Age	0.12	[-0.05, 0.28]	.00	[-.01, .02]	
Gender (Male)	5.62*	[1.20, 10.03]	.02	[-.01, .04]	
Simplified NS-SEC	0.66	[-0.18, 1.49]	.01	[-.01, .02]	
					R^2 = .024* 95% CI[.00,.06]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S9. Regression results assessing how age, gender, and simplified NS-SEC predict people's difference in perceived extrinsic mortality risk scores due to the pandemic

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	6.94**	[1.91, 11.97]			
Age	-0.05	[-0.14, 0.05]	.00	[-.01, .01]	
Gender (Male)	-2.34	[-4.82, 0.14]	.01	[-.01, .03]	
Simplified NS-SEC	0.05	[-0.42, 0.52]	.00	[-.00, .00]	
					R^2 = .012 95% CI[.00,.04]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S10. Regression results assessing how age, gender, and simplified NS-SEC predict people's degree of concern about spreading the virus in the event that they become infected

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	86.94**	[76.84, 97.04]			
Age	-0.06	[-0.25, 0.13]	.00	[-.01, .01]	
Gender (Male)	-5.46*	[-10.44, -0.47]	.01	[-.01, .03]	
Simplified NS-SEC	0.13	[-0.81, 1.08]	.00	[-.00, .00]	
					R^2 = .014 95% CI[.00,.04]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*
** indicates p < .05. ** indicates p < .01.*

Table S11. Regression results assessing how age, gender, and simplified NS-SEC predict people's perceptions of control of spreading the virus in the event that they become infected

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	56.03**	[45.36, 66.71]			
Age	0.12	[-0.08, 0.32]	.00	[-.01, .02]	
Gender (Male)	0.77	[-4.50, 6.04]	.00	[-.00, .00]	
Simplified NS-SEC	0.22	[-0.78, 1.22]	.00	[-.00, .00]	
					R^2 = .004
					95% CI[.00,.02]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr^2 *represents the semi-partial correlation squared. LL and UL indicate the lower and upper limits of a confidence interval, respectively.*

** indicates p < .05. ** indicates p < .01.*