Perceptions of control over different causes of death and the accuracy of risk estimations

Richard Brown,[1*] Elizabeth Sillence[1] and Gillian Pepper[1]
[1] Psychology Department, Northumbria University, Newcastle, UK.

[*]**Correspondence**
Richard Brown, Department of Psychology, Northumberland Building, Northumbria University, Newcastle, NE1 8SG. richard6.brown@northumbria.ac.uk

Abstract

Background: A large number of deaths could be avoided by improving health behaviours. The degree to which people invest in their long-term health is influenced by how much they believe they can control their risk of death. Identifying causes of death believed to be uncontrollable, but likely to occur, may provide actionable targets for health interventions to increase control beliefs and encourage healthier behaviours.

Method: We recruited a nationally representative online sample of 1,500 participants in the UK. We assessed perceived control, perceived personal likelihood of death, certainty of risk estimation, and perceived knowledge for 20 causes of death. We also measured overall perceived uncontrollable mortality risk (PUMR), and perceived prevalence for each of the Office for National Statistics' categories of avoidable death.

Findings: Risk of death due to cancer was considered highly likely to occur but largely beyond individual control. Cardiovascular disease was considered moderately controllable and a likely cause of death. Drugs and alcohol were perceived as risks both high in control and low in likelihood of death. However, perceptions of control over specific causes of death were found not to predict overall PUMR, with the exception of cardiovascular disease. Finally, our sample substantially overestimated the prevalence of drug and alcohol-related deaths in the UK.

Conclusions: We suggest that more can be done by public health communicators to emphasise the lifestyle and behavioural changes that individuals can make to reduce their general cancer risk. More work is needed to understand the barriers to engaging with preventative behaviours and maintaining a healthy heart. Finally, we call for greater journalistic responsibility when reporting health risks to the public.

Introduction

Approximately 23% of deaths in the UK in 2020 were considered avoidable, many of them being due to diseases often associated with unhealthy behaviours (e.g., cardiovascular disease, respiratory disease, and illnesses related to drug and alcohol use; (Office for National Statistics, 2022). The amount of effort that people invest in their long-term health and safety varies considerably between individuals. Therefore, understanding the factors that drive this variation in health effort may help to inform interventions aimed at reducing societally avoidable deaths.

Previous research suggests that the degree to which we invest in our long-term health is influenced by how much we believe we can control our risk of death. Perceived uncontrollable mortality risk (PUMR) is that portion of our risk of death which we believe cannot be mitigated by health effort (Brown et al., 2021a; Nettle, 2010; Pepper & Nettle, 2014a, 2014b, 2017a, 2017b). The Uncontrollable Mortality Risk Hypothesis (UMRH) states that those who believe they are more likely to die as a result of factors that are beyond their control should be less motivated to engage in positive health behaviours (Brown & Pepper, 2023; Pepper & Nettle, 2014a). The UMRH is supported by a growing body of theoretical, correlational and experimental evidence (Brown et al., 2021a, 2021b; Brown et al., 2022; Nettle, 2010; Pepper & Nettle, 2014a, 2014b). For example, Pepper and Nettle (2014b) found that the effect of lower socioeconomic status on reported health effort was mediated by PUMR. More recent research during the COVID-19 pandemic found that PUMR was associated with reduced adherence to guidelines on preventative health behaviours relating to diet, exercise and smoking (Brown et al., 2021a). Further study of PUMR and its driving factors may therefore be fundamental to understanding differences in health behaviours which may, in turn, help to reduce rates of avoidable death.

Whilst there are data on the extent to which risks are perceived as being societally controllable (Slovic, 2000), little is known about which causes of death are typically believed to be personally uncontrollable. Given the relationship between perceived control and health behaviour, understanding the specific perceptions that drive overall levels of PUMR may help to create interventions aimed at improving modifiable health behaviours. For example, do beliefs about the controllability of death due to cancer, cardiovascular disease or substance abuse have greater influence over PUMR compared to perceived control over environmental risks such as traffic accidents, exposure to violence or pollution? By identifying those risks widely believed to be uncontrollable, interventions that increase perceived control over these risks may help to improve associated health behaviours. Recent qualitative findings from a study exploring perceptions of control over different causes of death suggest differences between health conditions in the extent to which they are generally believed to be uncontrollable (Brown et al., 2022). For example, though dying from heart disease was broadly described as a controllable risk, the risk of dying from cancer was mostly considered to be uncontrollable. Furthermore, traffic accidents and the effects of air pollution were identified as potential causes of death generally believed to be beyond individual control due to uncertainty over the specific actions that could be taken to reduce risk. Investigating perceptions of control over mortality risk may help to inform targeted health interventions aimed at improving health behaviours associated with personally avoidable deaths. For example, if certain forms of cancer are widely believed to be beyond individual control, people may be less motivated to engage in the positive health behaviours likely to reduce their risk. In such cases, interventions tailored to emphasise the extent to which specific cancer risks are modifiable through behaviour may prove effective.

It is also important to consider the extent to which people are accurate in their estimations of the risks they face. Overestimating the likelihood of dying from certain causes of death may increase overall PUMR, potentially disincentivising preventative health behaviours. This may suggest the need for informational interventions to align perceptions of risk with objective exposures to encourage the public to respond more appropriately to the risks they face. Alternatively, where levels of risk associated with certain causes of death are accurately perceived by the public, research may look to identify the sources of risk that inform these beliefs in order to apply similar informational strategies to other causes of death. When studying perceptions of mortality risk, a *primary bias* has consistently been reported in which people typically overestimate rare risks to their health and underestimate common risks (Hakes & Viscusi, 2004; Lichtenstein et al., 1978). For example, Slovic (1978) found that people typically overestimate their risk of dying as a result of homicide or natural disaster, but typically underestimate the likelihood of dying due to diabetes, cancer or stroke. Studying the perceived prevalence of different mortality risks may help to understand general beliefs about health and risk in the UK. However, to our knowledge, no study has compared the perceived prevalence of different leading causes of avoidable death in the UK population with objective measures of risk. Investigating mortality risk perceptions is of particular interest in response to potential changes to perceptions resulting from the COVID-19 pandemic. The perceived prevalence of common diseases may have been affected by the widely discussed neglect of major causes of death by governments during the COVID-19 pandemic (Clerk, 2021; Holakouie-Naieni & Nematollahi, 2020; Poorolajal, 2020). Risk of dying due to infectious disease is also likely to be particularly salient in the wake of COVID-19. Additionally, measuring perceptions of control associated with catastrophic risks such as those resulting from nuclear attack or climate change may also capture growing public concern regarding conflict in Ukraine and the climate crisis (Drews et al., 2022; United Nations, 2022). With respect to biases in perceptions of different causes of avoidable death, it is likely that the least common causes of avoidable death (accidental injuries, violence and infectious disease etc.,) will be overestimated, whereas the perceived prevalence of the most common causes of avoidable death (cancers, heart disease and respiratory disease) will be underestimated (Hakes & Viscusi, 2004).

The aim of this study is to investigate perceptions of control over different causes of death in a nationally representative sample of the UK. Identifying the causes of death generally believed to be beyond individual control and investigating the extent to which specific perceptions of risk influence overall levels of PUMR will increase our understanding of the relationship between perceptions of control and health behaviours. Exploring the perceptual differences between a range of causes of death will help to identify targets for future health interventions directed at improving health behaviours and reducing rates of personally avoidable death.

Methods

This study was approved by the Northumbria University research ethics system (ethical approval number 41708). Our measures, predictions, and analytical plan are registered with the Open Science Framework [osf.io/dgwna].

Cognitive interviews were conducted to assess participants' understanding of the questionnaire. Six participants were interviewed following recommendations for conducting cognitive interviews for refining survey items (Peterson et al., 2017). Pilot testing of the questionnaire was subsequently conducted to further develop the survey items and to test functionality. We recruited 39 participants for our pilot based on sample size recommendations for developing survey studies (Hertzog, 2008). The refined questionnaire was presented to participants via the recruitment platform Prolific.co between 4-6 May 2022. Participants were paid incentive fees through this platform which were in line with the UK living wage (£8.91

per hour), in accordance with Northumbria University's ethical guidelines for conducting research.

Our target sample size was 1,500 participants based on recent guidance and practices set by YouGov and the Office for National Statistics (ONS) for surveying the opinions and perceptions of the UK public (Office for National Statistics, 2021; YouGov, 2021). Prolific provides a UK representative sample by screening participants based on age, gender, and ethnicity in proportion to data derived from the UK's 2021 census. From this sample, four participants were excluded due to technical errors during data collection, 24 participants were excluded due to inconsistencies between their Prolific profile information and their survey responses, five participants were excluded for taking over 90 minutes to complete the survey questionnaire, and those who reported the number of years in post-16 education as above 25 (n = 4) were removed as extreme outliers as their responses suggested a possible misinterpretation of the question. Our final sample comprised 1,463 participants.

Personal Information

Personal information was recorded for participants' age, gender, and education. Discretionary income was measured by asking participants how much their household has each month to spend on non-essentials. Participants also provided scores for the Subjective Discretionary Income (SDI) scale (O'Guinn & Wells, 1989; Rader et al., 2011). This scale asked participants the extent to which they agreed with three statements about the perceived ability of their household finances to satisfy their wants and needs on a five-point Likert scale ranging from '*strongly disagree*' to '*strongly agree*'.

Living and working environment

Participants were asked whether they believed their current neighbourhood is a safe place to live on a seven-point scale ranging from '*strongly disagree*' to '*strongly agree*' (An et al., 2017; Prins et al., 2013). Occupational exposure to risk was measured by using the Physical Working Environment Subscale from the European Working Conditions Survey 2015 (Eurofound, 2017). Participants reported their exposure to 13 physical conditions of employment on a seven-point Likert scale ranging from '*never*' to '*all of the time*'. These survey items included risks due to occupational activities that include maintaining tiring or painful positions, carrying or moving heavy loads, and being exposed to hazardous materials, high temperatures or noisy environments.

Perceptions of risk

Participants provided a measure of perceived uncontrollable mortality risk (PUMR; Pepper & Nettle, 2014b). Participants were asked to provide a score for their believed likelihood of living to the current average UK life expectancy at birth for their gender, provided they made the maximum effort to look after their health. Participants responded on a sliding scale from 0 *'no chance'* to 100 '*certain*'. Responses were subtracted from 100 to provide PUMR scores which represent that portion of mortality risk which the participant believes is beyond their control.

Participants answered questions about their perceived control, personal likelihood of death, certainty of risk estimation, and perceived knowledge for 20 causes of death (see Table 1). These causes of death were selected from the ONS' most common categories of avoidable deaths in the UK, public risks identified as most serious and likely by the UK National Risk Register 2020, as well as causes of death consistently highlighted by recent qualitative findings on perceptions of control over risk (Brown et al., 2022; Cabinet Office, 2020; Office for National Statistics, 2022). Participants were asked how much they thought they could control their own risk of dying from each cause of death on a sliding scale from 0 '*no control*' to 100 '*complete control*'. Participants were also asked how likely they thought they were to die from each cause of death before the age of 81. Scores were provided on a sliding scale from 0 '*very unlikely*' to 100 '*very likely*'. Participants' certainty over their personal estimations of risk were then assessed on a sliding scale from 0 '*not at all sure*' to 100 '*completely sure*'. Finally, participants were asked how knowledgeable they thought they were about each cause of death on a sliding scale from 0 '*not at all knowledgeable*' to 100 '*extremely knowledgeable*'.

Table 1. List of causes of death

High-level categories	*Low-level categories*
Neoplasms	1. General cancer risk
	2. Breast cancer shown to female participants / Prostate cancer shown to males
	3. Lung cancer
	4. Bowel cancer
Diseases of the circulatory system	5. Heart disease
Diseases of the respiratory system	6. Respiratory disease
Alcohol and drug related	7. Alcohol-related death
	8. Recreational drug-related death
Infectious disease	9. Infectious disease other than COVID-19
Injuries	10. Accidental injury in the home (such as accidental fire or injury from falling)
	11. Injuries incurred in a travel accident (e.g., a motor vehicle, train, or plane crash)
	12. Injuries sustained by illegal violence
	13. Illness or injury caused by occupation (e.g., injury resulting from heavy machinery or exposure to infection or hazardous chemicals)
COVID-19	14. COVID-19
Environmental risks	15. Illness from air pollution
	16. Illness from water pollution
	17. Illness from contaminated food supply
Catastrophic risks	18. Natural disaster (such as a flood or forest fire)
	19. CBRN attack (chemical, biological, radiological or nuclear attack)
Antimicrobial Resistance	20. Antimicrobial resistance

Perceived prevalence of avoidable death and accuracy of risk estimations

We measured participants' perceived prevalence of the ONS' seven leading causes of avoidable death in the UK (Neoplasms, Diseases of the circulatory system, Diseases of the Respiratory system, Alcohol and drug-related death, Infectious disease, Injuries, and 'Other' risks). Participants were asked, '*A significant portion of annual deaths in the UK could be avoided, either through public health intervention or effective treatment. For every 100 avoidable deaths in the UK in 2020, how many do you think, on average, resulted from each of the following causes of avoidable death?*' Scores were provided on a sliding scale from 0 '*none*' to 100 '*all deaths*'. The total summed score for portion of avoidable deaths for all causes had to equal 100. Once the summed total reached 100, subsequent options could not be scored above 0 until previous scores were reduced. All measures presented causes of death in a randomised order to prevent potential scoring bias.

Finally, we calculated the overall accuracy of perceptions of the prevalence of avoidable deaths for each cause. This was calculated by measuring the absolute distance between perceived prevalence scores for each cause and the percentage of avoidable deaths accounted for by each category reported by the ONS' most recent release on Avoidable Mortality in the UK (Office for National Statistics, 2022).

Analysis

All statistical analyses were performed using R (R Core, 2021). The following packages were used for data processing, analysis, and visualisation: tidyverse (Wickham et al., 2020), psych (Revelle, 2021), Rmisc (Hope, 2013), bestNormalize (Peterson, 2021), jmv (Selker et al., 2021), factoextra (Kassambara & Mundt, 2021), REdaS (Maier, 2015), interactions (Long, 2020), moments (Komsta & Novomestky, 2015), lmtest (Zeileis & Hothorn, 2020), olsrr (Hebbali, 2020), ggcorrplot (Kassambara, 2019), plotly (Sievert, 2020), and apaTables (Stanley, 2021). The level of statistical significance for all tests was set at $p < .01$ in accordance with guidance for the analysis of medium to large sample sizes (e.g., $n > 1000$), and the need to adjust levels of significance (Priest, 2005). For the regression analysis presented, we first ran additional regression analyses to identify significant predictors from our socioeconomic, demographic and occupational exposure variables (age, gender, education, income, neighbourhood safety and occupational risk; see supplement Table S1). Significant predictors were then included as control variables. For violations of the assumption of normality, the R package 'bestNormalize' was used to transform variables to produce normally distributed data (Peterson, 2021).

The data associated with this study were also used to produce a second article '*Individual characteristics associated with perceptions of control over mortality risk and determinants of health effort*' (Brown et al., 2023), which discusses the individual characteristics associated with perceptions of control over mortality risk and determinants of health effort. This second article is available as a preprint alongside our data, code, materials and pre-registration with the Open Science Framework [https://osf.io/dgwna].

Results

Of the 1,463 participants included in our analysis, 742 were female, 714 were male and seven reported a different gender identity. Ages ranged from 18 to 87 years ($M = 45.58$, $SD = 15.53$). Years in post-16 education ranged from 0 to 23 years ($M = 5.12$, $SD = 3.48$). Monthly discretionary income ranged from -£1,100 (indicating greater monthly outgoings than incomings) to £7,500 ($M = 306.31$, $SD = 463.63$) and the mean score for Subjective Discretionary Income was 8.50 out of 15 ($SD = 2.64$). Participants indicated that they generally '*agree'* that they feel safe in their neighbourhood ($M = 5.55$ out of 7, $SD = 1.15$). Of those in employment ($n = 999$), scores for occupational exposure to the 13 physical risks from the Physical Working Environment Subscale from the European Working Conditions Survey 2015

(Eurofound, 2017) ranged from 13-71 out of a possible 91, with the average score (M = 23.48, SD = 9.47) suggesting that most participants believe they are '*almost never*' exposed to physical risks in the workplace.

Perceived control over each cause of death

The least controllable causes of death were reported to be chemical, biological, radiological or nuclear attacks (M = 12.40 out of 100, SD = 22.01), natural disasters (M = 28.80, SD = 29.56) and the threat of antimicrobial resistance (M = 32.24, SD = 25.92), followed by four of the five categories of cancer risk ($M_{general}$ = 33.41, $SD_{general}$ = 24.10; M_{breast} = 33.45, SD_{breast} = 25.12; $M_{prostate}$ = 35.95, $SD_{prostate}$ = 24.62; M_{bowel} = 37.38, SD_{bowel} = 25.39). Risk of death due to drugs and alcohol were considered most controllable (M_{drugs} = 89.23, SD_{drugs} = 20.66; $M_{alcohol}$ = 87.37, $SD_{alcohol}$ = 19.65; see Figure 1).

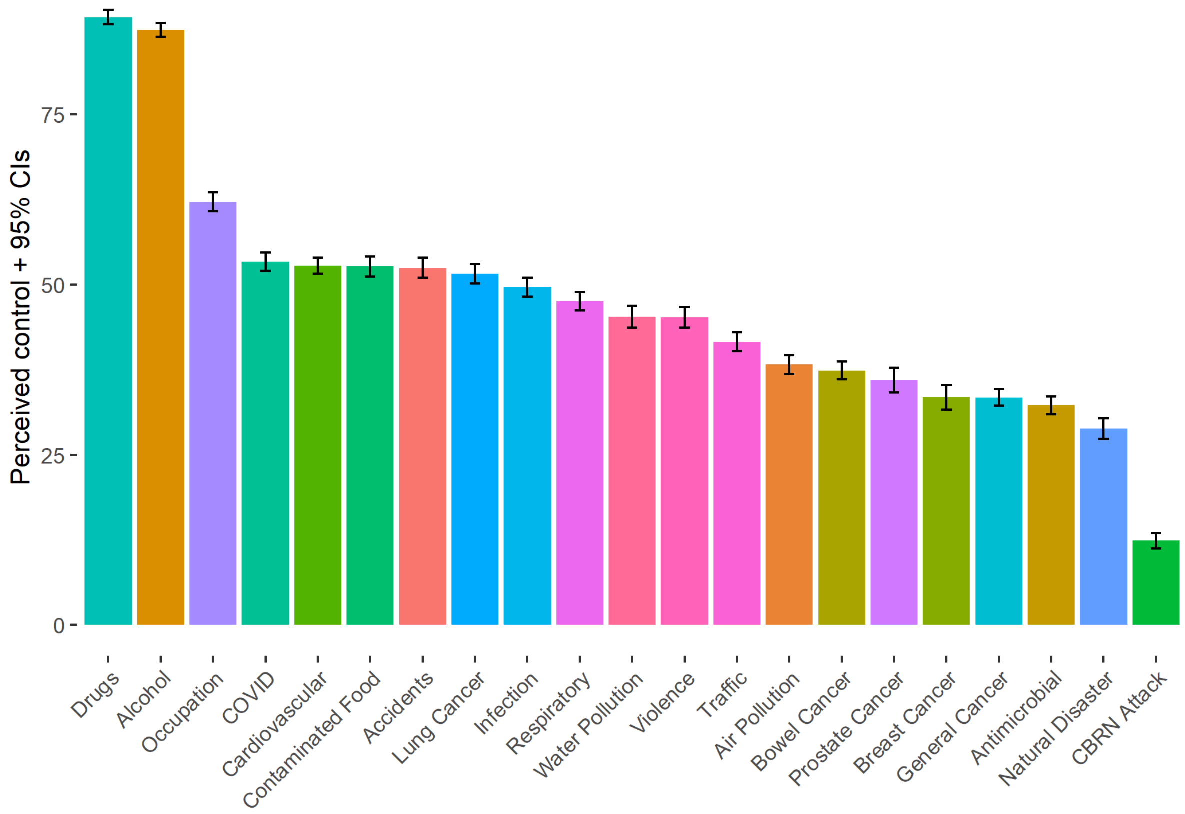

Figure 1. Perceived control over each cause of death.

Bars represent mean scores out of 100 for each cause of death, with 95% confidence intervals. N = 1,463 for all causes except breast cancer (n = 742 females) and prostate cancer (n = 714 males).

Perceived likelihood of dying due to each cause of death

Perceived personal likelihood of death was highest for general cancer risk (M = 51.11, SD = 24.34), followed by cardiovascular risk (M = 47.64, SD = 24.83), and the remaining four categories of cancer M_{breast} = 41.70, SD_{breast} = 22.62; $M_{prostate}$ = 37.36, $SD_{prostate}$ = 24.44; M_{bowel} = 36.03, SD_{bowel} = 23.48; M_{lung}= 30.38, SD_{lung} = 24.46. Personal death due to drugs was considered least likely (*M* = 7.91, *SD* = 18.80).

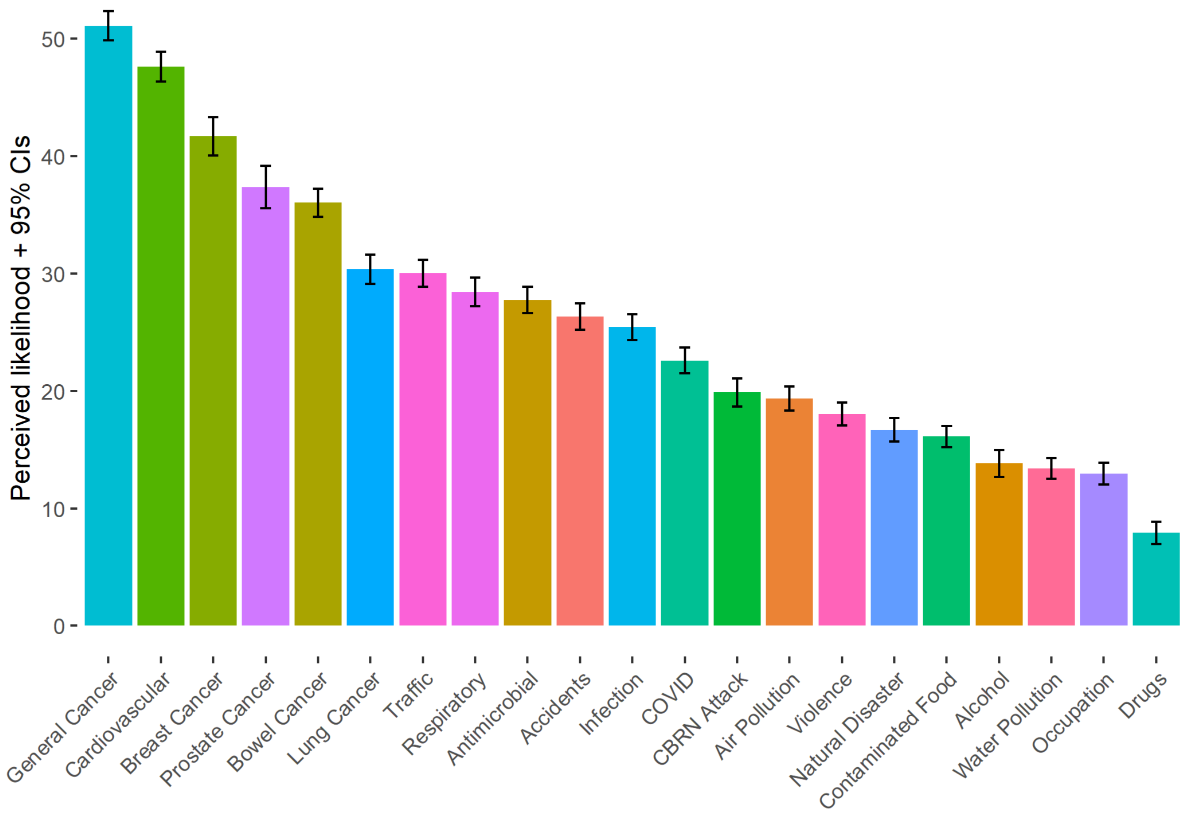

Figure 2. Perceived personal likelihood of dying due to each cause of death.

Bars represent mean scores out of 100 for each cause of death, with 95% confidence intervals. N = 1,463 for all causes except breast cancer (n = 742 females) and prostate cancer (n = 714 males).

Overall, drugs and alcohol were perceived as risks that were both high in control and low in likelihood of death. Cardiovascular disease was considered reasonably controllable and a likely cause of personal death, whereas cancers (with the exception of lung cancer) were considered reasonably uncontrollable and likely causes of personal death (see Figure 3).

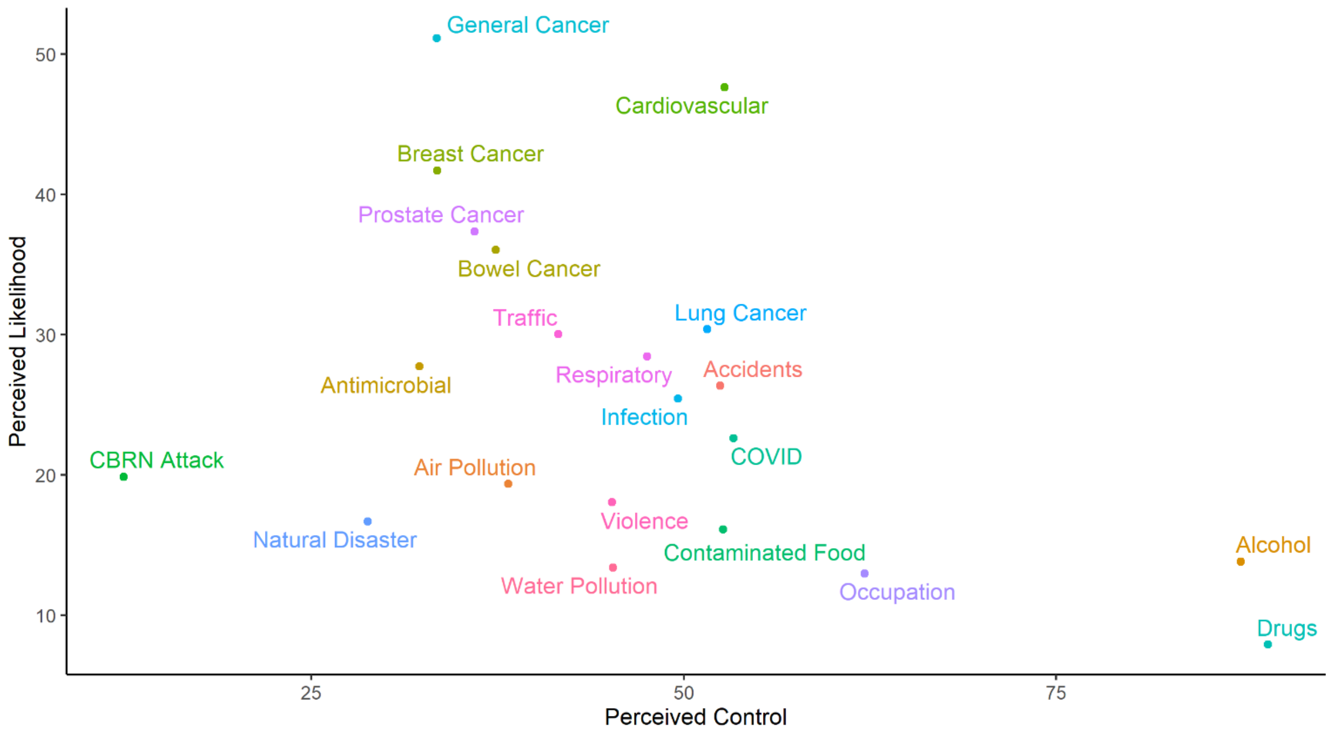

Figure 3. Perceived control and likelihood of death due to each cause of death.

N = 1,463 for all causes except breast cancer (n = 742 females) and prostate cancer (n = 714 males).

Perceived uncontrollable mortality risk (PUMR)

The mean score for PUMR was 26.91 out of 100 (SD = 17.08). All scores for perceived control over the ten high-level causes of death (see Table 1) were significantly correlated with PUMR, such that greater perceived control over individual risks was associated with lower PUMR. However, the effect sizes were small (ranging from r = -.11 to -.29). Furthermore, when included in a regression model containing perceptions of control over individual causes of death as predictors, and PUMR as the outcome variable, only perceived control over circulatory disease (β = -.19, 95% CI [-0.25, -0.13]) and perceived control over drugs and alcohol (β = -.08, 95% CI [-0.13, -0.02]) were statistically significant predictors of PUMR (see Table 2).

Table 2. Regression analyses showing predictors of perceived uncontrollable mortality risk.

Predictor	*b*	*b* 95% CI [LL, UL]	*beta*	*beta* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	*r*	Fit
(Intercept)	0.00	[-0.05, 0.05]						
Neoplasms	-0.00	[-0.07, 0.06]	-0.00	[-0.06, 0.06]	.00	[-.00, .00]	-.19**	
Circulatory	-0.20**	[-0.26, -0.13]	-0.19	[-0.25, -0.13]	.02	[.01, .04]	-.29**	
Respiratory	-0.03	[-0.09, 0.04]	-0.03	[-0.09, 0.04]	.00	[-.00, .00]	-.22**	
Drugs/Alcohol	-0.08**	[-0.14, -0.03]	-0.08	[-0.13, -0.02]	.00	[-.00, .01]	-.15**	

Infections	-0.05	[-0.11, 0.02]	-0.05	[-0.11, 0.02]	.00	[-.00, .00]	-.20**	
Injuries	-0.02	[-0.09, 0.05]	-0.02	[-0.09, 0.05]	.00	[-.00, .00]	-.19**	
COVID19	-0.04	[-0.10, 0.03]	-0.04	[-0.10, 0.02]	.00	[-.00, .00]	-.20**	
Environmental	0.02	[-0.05, 0.09]	0.02	[-0.05, 0.09]	.00	[-.00, .00]	-.17**	
Catastrophic	0.02	[-0.05, 0.08]	0.02	[-0.05, 0.08]	.00	[-.00, .00]	-.11**	
Microbes	-0.06	[-0.11, 0.00]	-0.05	[-0.11, 0.00]	.00	[-.00, .01]	-.15**	
Subjective Discretionary Income	-0.11**	[-0.16, -0.05]	-0.11	[-0.16, -0.05]	.01	[-.00, .02]	-.19**	
Discretionary Income	-0.06*	[-0.11, -0.00]	-0.06	[-0.11, -0.00]	.00	[-.00, .01]	-.15**	
Perceived Neighbourhood Safety	-0.08**	[-0.13, -0.03]	-0.08	[-0.13, -0.03]	.01	[-.00, .01]	-.14**	
								R^2 = .138** 95% CI[.10,.16]

*Note. A significant b-weight indicates the beta-weight and semi-partial correlation are also significant. b represents unstandardized regression weights. beta indicates the standardized regression weights. sr2 represents the semi-partial correlation squared. r represents the zero-order correlation. LL and UL indicate the lower and upper limits of a confidence interval, respectively. * indicates p < .05. ** indicates p < .01.*

Certainty of risk estimations and perceived knowledge of causes of death

Perceptions of control and likelihood of death were associated with participants' certainty of their own risk estimations and their perceived level of knowledge, though the effects were small (see Table 3; (Ellis, 2010). The more knowledgeable participants felt they were about a specific cause of death, the more certain they were of their estimation of risk (r = .27, 95% CI [.26, .28]). The more certain participants were of their estimation of risk, the more control they felt they had over their risk of death (r = .24, 95% CI [.23, .25]). Finally, the more control participants felt they had over their risk of death, the less likely they felt they were to die from a specific cause (r = -.18, 95% CI [-.17, -.19]). For full details of the differences between causes of death in perceived certainty and knowledge reported by our sample, see supplement Figures S1-2.

Table 3. Spearman correlations between overall perceptions of control, likelihood, certainty and knowledge of causes of death.

Variable	*M*	*SD*	1	2	3
1. Control	47.39	31.54			
2. Likelihood of death	25.17	24.34	-.18** [-.19, -.17]		

3. Certainty of risk estimation	57.39	31.07	.24** [.23, .25]	-.14** [-.15, -.13]	
4. Personal knowledge	47.56	28.60	.18** [.17, .19]	.12** [.11, .13]	.27** [.26, .28]

*Note. M and SD are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates p < .05. ** indicates p < .01.*

Accuracy of perceived prevalence of avoidable deaths in the UK

Alcohol and drugs were considered to be the most prevalent category of avoidable death, with participants, on average (mean), estimating that these risks account for 22% of avoidable deaths in the UK. This was followed by cancers which were believed to account for 19% of avoidable deaths. Compared to the actual prevalence of avoidable deaths in the UK (calculated by the ONS's most recent release on avoidable deaths; Office for National Statistics (2022)), on average participants overestimated the prevalence of avoidable deaths due to alcohol and drugs by 10%, infectious disease by 8% and injuries by 7%. Participants underestimated the prevalence of avoidable deaths due to cancers by 16% and cardiovascular disease by 14%. Figure 4 shows the accuracy of prevalence estimation for all categories of avoidable death (for a comparison of perceived and actual prevalence of avoidable deaths in the UK, see supplement Figure S3).

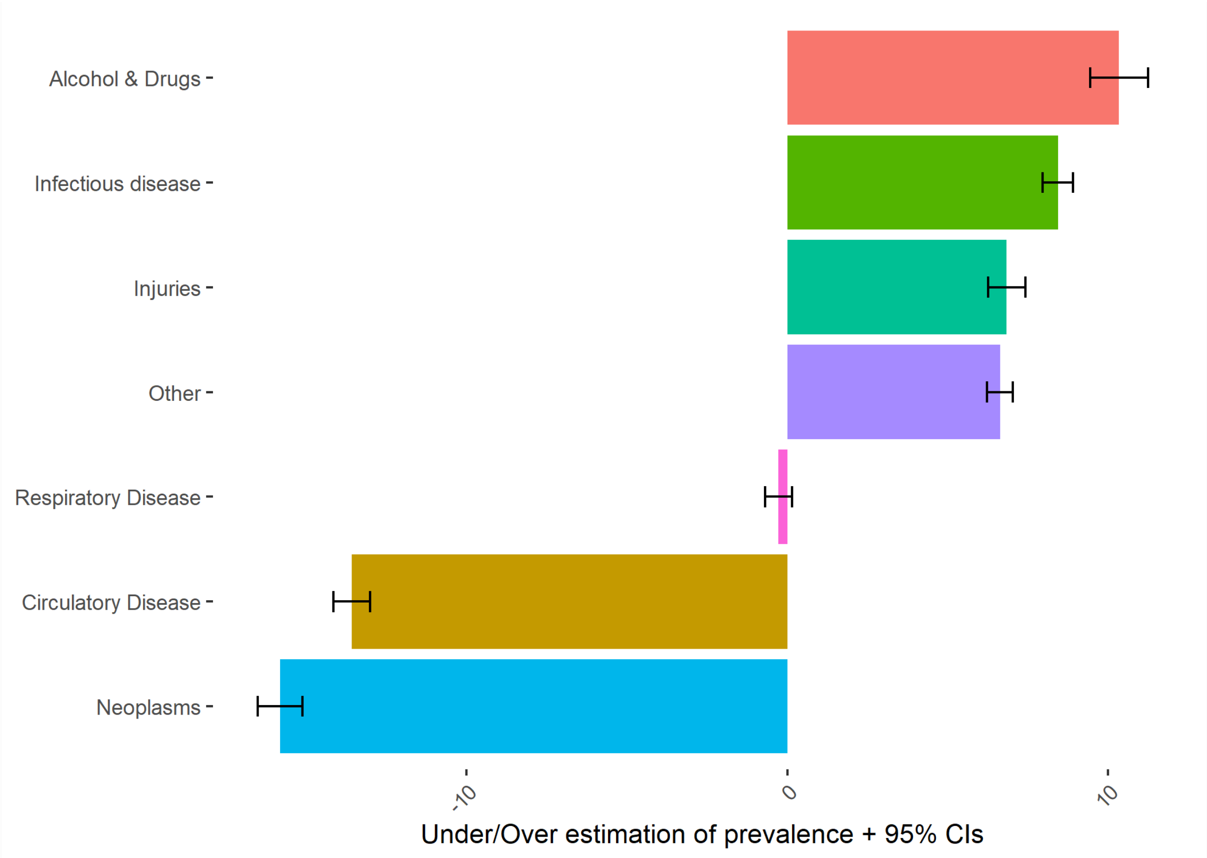

Figure 4. Accuracy of estimation of prevalence of avoidable deaths in the UK.

Finally, causes of avoidable death were ranked in terms of participants' perceived level of prevalence, the actual prevalence of avoidable death in the UK, and participants' perceived personal likelihood of death. The top three causes of avoidable death that participants reported they were most likely to die from corresponded with the three most prevalent causes of avoidable death in the UK (cancer, circulatory disease, and respiratory disease). Conversely, drugs and alcohol were believed to be the most prevalent causes of avoidable death in the UK, but are ranked fourth in actual prevalence, and were ranked last in perceived personal likelihood of death (see Figure 5).

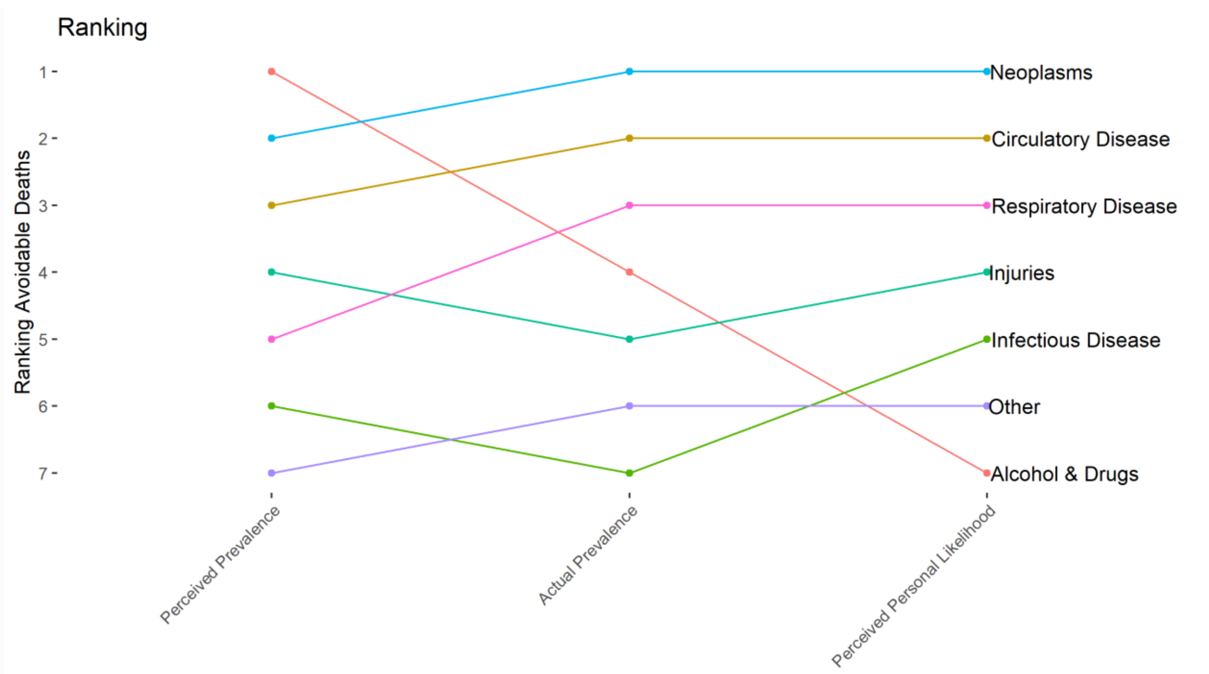

Figure 5. Causes of avoidable death ranked by perceived prevalence in the UK, actual prevalence in the UK, and perceived personal likelihood of death.

Discussion

This study investigated perceptions of control over different causes of death and aimed to capture the accuracy of risk estimations by measuring perceived prevalence of avoidable deaths in the UK. Our findings reflect the risk perceptions and control beliefs of an online UK-representative sample recruited in May 2022. By considering the influence of specific control beliefs on overall levels of PUMR, as well as the differences in perceptions observed between causes of death, we provide insights that may inform interventions aimed at encouraging preventative health behaviours.

Perceptions of control and likelihood for different causes of death

Perceptions of control and likelihood of death varied by cause but largely reflected findings from past literature, actual rates of prevalence in the UK, as well as expected levels of control over certain risks. For example, drugs and alcohol were considered the most controllable causes of death. Notwithstanding the neurobiological, genetic and environmental factors that can influence addiction and resulting death (Koob & Volkow, 2016; Wong et al., 2011), levels of consumption of alcohol and illicit drugs are often associated with self-efficacy and individual control (West & Brown, 2013). Therefore, it is unsurprising that participants typically reported feeling that they can control their risk of dying due to drugs and alcohol but cannot control the risks they face from natural disasters or chemical, biological, radiological or nuclear attacks. Similarly, the present study offers support for previous findings that people typically feel they have moderate control over their risk of dying due to cardiovascular disease but perceive little control over their risk of cancer-related death (Brown et al., 2022; Curtin et al., 2018; Wang et al., 2009). Finally, participants rated cancer and cardiovascular disease as the most probable causes of their own death. This mirrors the high level of prevalence of these causes of death in the UK, as they were the two most reported categories of avoidable death in 2020 (Office for National Statistics, 2022).

By considering perceptions of control and likelihood together, cancer-related death (due to either bowel, breast, prostate or general cancer risk) was perceived by our sample as both likely to occur, and largely beyond individual control. All five responses for cancer scored in the top six most likely causes of individual death, and only natural disasters, catastrophic attacks and antimicrobial resistance were considered less controllable. The exception being lung cancer, which was considered less likely and more controllable than other types of cancer. This is likely due to the success of extensive health campaigns to inform the public of the harms of smoking

(Durkin et al., 2012; Proctor, 2012). Feeling more knowledgeable about a cause of death was associated with greater certainty over risk estimations which in turn was associated with higher perceived control. Our findings suggest that people believe they have a moderate degree of knowledge concerning their risk of dying from cancer, but are unsure as to the accuracy of their risk estimations. The combination of high perceived likelihood and low perceived control suggests that cancer may be a suitable target for interventions aimed at increasing perceptions of control to encourage preventative health behaviours. As discussed, the UMRH stresses that those who believe they are more likely to die as a result of factors that are beyond their control should be less motivated to engage in positive health behaviours (Pepper & Nettle, 2014a). Furthermore, findings from the broader fear appeal literature (including work on protection motivation theory and extended parallel process model) highlight that where individuals consider a risk to be largely uncontrollable, health messages that increase levels of fear by highlighting the likelihood of a threat are expected to be ineffective in encouraging healthy behaviours (Bui et al., 2013; Floyd et al., 2000; Popova, 2012; Rogers et al., 1983; Rogers, 1975; Witte, 1992; Witte & Allen, 2000). Increasing cancer rates in recent years have been widely reported in the UK, with the estimated lifetime risk of being diagnosed with cancer now 1 in 2 (Cancer Research UK, 2018a). This widely reported increase in cancer rates is likely to increase levels of fear associated with the threat of cancer. In response to this increasing threat, public health narratives have focussed on the importance of highlighting timely screening and treatment. For example, focus groups with NHS health professionals reported that health communicators typically highlight the importance of screening for cancer risk, whereas the influence of lifestyle on cancer risk is rarely discussed (Usher-Smith et al., 2017). However, doing more to emphasise the lifestyle and behavioural changes that individuals can make to lessen their risk of developing cancer may help to address low levels of perceived control and ultimately to encourage preventative health behaviours.

Identifying and communicating the causal connections between certain behaviours and the incidence of specific types of cancers is complex and difficult to achieve (Blackadar, 2016). Given the complexity of the relationships between health behaviours and specific types of cancer, a recent review of diet, nutrition and cancer risk suggested that public health communicators should aim to highlight the importance of positive health behaviours for the reduction of general cancer risk, rather than targeting specific types of cancer (Key et al., 2020). From our cancer variables, the general risk of a cancer-related death was typically rated as more likely and less controllable than any of the specific types of cancer. Therefore, the finding that people in the UK typically perceived general cancer risk as being highly likely and largely beyond their personal control may further suggest that it is a suitable target for interventions aimed at improving perceptions of control in order to encourage preventative health behaviours.

The relationship between perceptions of control over specific causes of death and PUMR

Contrary to the predictions in our preregistration, perceptions of control for eight out of ten high-level causes of death were found not to be statistically significant predictors of overall levels of PUMR. Only perceptions of control over cardiovascular disease (small effect size; (Ellis, 2010) and drugs and alcohol (trivial effect size; (Ellis, 2010) predicted PUMR. This suggests that overall perceptions of control over mortality risk are not largely driven by perceptions of control over specific causes of death. We discuss a number of possible explanations for why this may be the case.

The UMRH suggests that humans may have developed an adaptive psychological mechanism that responds to environmental cues of risk to determine the optimal level of investment in preventative health (Pepper & Nettle, 2014a, 2014c, 2017a). Previous research has shown how humans evolved to respond to immediate threats from surrounding predators (Blanchard et al., 2011) and to detect indicators of imminent violence (White et al., 2012). It has also been suggested that humans evolved to respond to cues of unpredictability in their environment, such as the loss of a parent or changes to one's surroundings (Young et al., 2020). However, given the relative safety and stability of the modern world compared to our ancestral environment, it is unclear how equipped we are to detect and respond appropriately to the most likely causes of harm we face today. For example, as previously discussed, cancer is the most prevalent category of avoidable death in the UK (Office for National Statistics, 2022) and the causal pathways between lifestyle behaviours and cancer-related death are complex and difficult to establish (Blackadar, 2016). Given this complexity, and the often lengthy timelines of cancer development (Cancer Research UK, 2018b), we are unlikely to have evolved psychological mechanisms capable of recognising cues of increasing cancer rates and the prevalence of lifestyle behaviours that are harmful to our health. Similarly, with respect to wider existential threats, though humans are able to detect the short-term variability of local weather (Mumenthaler et al., 2021), it is unlikely that we have evolved to detect long-term patterns of climate change. Furthermore, the channels of information through which we learn about the risks most likely to cause us harm are sure to differ from our ancestral environments. For example, increasing numbers of people are using social media and internet search engines to seek out information about risks to their health and mortality (Liang & Wang, 2021). It is possible that individual assessments of control over specific causes of death may be more influenced by informational environments than environmental conditions. Therefore, the safety and stability we experience compared to our ancestral environments, the difficulty of personally detecting the complex patterns of the mortality risks we face today, and the informational environments through which we learn about specific risks, may all help to explain why perceptions of control over common contemporaneous causes of death do not appear to drive overall perceptions of uncontrollable mortality risk. Given the difficulty of establishing the drivers of PUMR, future studies may look to use machine learning models to unravel the ties between informational environments and subsequent risk perceptions. For example, Aka and Bhatia (2022) recently developed a language model using text explanations on NHS websites to quantitatively predict lay health perceptions of the severity of everyday diseases. Further study may also look to compare objective measures of environmental risk with informational environments to investigate the influence they have on perceptions of specific risk.

If overall levels of PUMR are not largely driven by aggregating perceived control over specific causes of death, what factors do shape PUMR? It is possible that upbringing, experiences in adolescence, and cultural narratives play a role in determining levels of PUMR. For example, people who experience childhood trauma typically report greater external locus of control than those who don't (Roazzi et al., 2016), experiences of violence during adolescence predict heightened perceptions of risk in adulthood (Macmillan, 2000), and different cultural backgrounds predict optimism and overall perceived risk with respect to external threats, such as natural disasters and terrorist attacks (Gierlach et al., 2010). Additionally, researchers in the UK found that patients with South Asian heritage are more likely to believe that heart disease is unpreventable and that it is caused by fate (Curtin et al., 2018; Darr et al., 2008). Understanding the influence of cultural narratives around heart disease is important as they may impact the willingness of patients to engage in preventative health behaviours. In the present study, perceived control over cardiovascular disease was found to be the strongest predictor of overall levels of perceived uncontrollable mortality risk. Given the discussed negative association between PUMR and reported health effort, understanding beliefs about the controllability of cardiovascular disease may help to encourage positive health behaviours.

Only drugs and alcohol, occupational, and COVID-related deaths were considered more controllable by our sample. Despite indicating a reasonable degree of perceived control, our sample considered cardiovascular disease to be the second most likely cause of personal death after cancer. This high degree of perceived likelihood may indicate that, although participants felt their risk of a cardiovascular-related death could potentially be controlled, they are not currently acting within their powers to mitigate the risk. Barriers to pursuing a healthy lifestyle can include poor mental health as well as experiences of stigma (structural, social, and self) (Graham et al., 2013). Research suggests that health and wellbeing related services are key to providing a structural element through which society can promote healthier living, in cooperation with the individual (Tuohimaa, 2014). There is also an established body of empirical research on neighbourhood effects on health behaviours (Galster, 2012). The topography of an area, and whether residential areas are within walking distance of essential services is likely to influence aerobic activity (Flowerdew et al., 2008). Additionally, living in a food desert creates a clear barrier to pursuing a healthy lifestyle. ‘Food deserts’ refer to neighbourhoods that have limited access to nutritious and affordable food (Whitacre et al., 2009). Similarly, living in close proximity to processed food outlets poses additional challenges to maintaining a healthy diet. Further study may look to disentangle the various neighbourhood effects that can influence an individual’s motivation and ability to mitigate their risk of a cardiovascular-related death.

Perceived prevalence of avoidable death

The findings from the present study offer support for the prediction made in our preregistration concerning the presence of a *primary bias* in risk perception, whereby people typically overestimate rare risks to their health and underestimate common risks (Hakes & Viscusi, 2004; Lichtenstein et al., 1978; Slovic, 1978). We found that more common causes of avoidable death (cancers and cardiovascular disease) were underestimated when compared to the actual prevalence in the UK, whereas less common causes of avoidable death (injuries, infectious disease, drugs and alcohol) were overestimated. A possible explanation for this bias in the estimated prevalence of different categories of avoidable death is the way in which the media report on mortality risks. For example, Ritchie and Roser (2018) found that in the US, despite around one-third of deaths being due to heart disease, this cause of death receives only 2-3% of media coverage relating to death. They also found that though just under one-third of US deaths resulted from cancer, this mortality risk receives only 13-14% of media coverage. Contrast this with media coverage of violent deaths; which represents more than two-thirds of overall coverage on causes of death, despite accounting for fewer than 3% of annual US deaths. Additionally, Pilar et al. (2020) recently highlighted how the actual causes of death in the US are misaligned with health-related media attention, as well as with policy attention and federal spending. They suggested that this misalignment between media coverage and the actual prevalence of different causes of death is likely to shape the public's perception of the health risks they face.

Media coverage may be particularly impactful on perceptions of risk concerning drugs and alcohol. For example, media sensationalism and alarmist rhetoric in response to high-profile overdoses and celebrity deaths can strongly affect perceptions of risk (Brown & Midberry, 2022; Murji, 2020; Orsini, 2015). In the UK there has been a growing focus on binge drinking and anti-social behaviour by the media, often framing problem drinking as a criminal justice issue rather than as a health issue (Meier, 2010). Extreme portrayals of alcohol and drug-related issues by the media may affect perceptions of control and the perceived likelihood of a substance-related death. Our findings suggest that people in the UK think that the risks from drugs and alcohol are highly controllable and unlikely to result in their own death. Our sample reported feeling knowledgeable about these risks and moderately certain in their estimations. Despite this, our sample substantially overestimated the prevalence of drug and alcohol-related deaths in the UK. This might suggest that drug and alcohol-related deaths are believed to be risks that are likely to be experienced by others, but not by oneself. An exploration of UK drinking trends by the Joseph Rowntree foundation found that people typically underestimate the amount of alcohol they consume (Smith & Foxcroft, 2009). Furthermore, in a cross-sectional study of the drinking habits of approximately 10,000 global participants, the tendency to underestimate one's own alcohol consumption was found to be common in the US, Canada and Australia, and most common among UK males (Garnett et al., 2015). This combination of sensationalising drug and alcohol-related issues, but underestimating consumption may decrease the perceived likelihood of suffering drug or alcohol-related deaths, whilst increasing the perceived prevalence of risk in the wider community. This suggests a growing need for ethical journalism when reporting on issues that are likely to influence public perceptions of risk and, thereby, subsequent health behaviours. For example, research during the COVID-19 pandemic highlighted the importance of consulting public health professionals when communicating health threats to the public (Kyriakidou et al., 2021).

Limitations

The results of this study are not without limitation. For example, it is possible that the causes of death that we included in our survey do not fully represent those with the greatest influence on perceptions. We included a broad range of causes of death by referencing the ONS' categories of avoidable death in the UK, the UK National Risk Register 2020, and recent qualitative findings on perceptions of control over risk (Brown et al., 2022; Cabinet Office, 2020; Office for National Statistics, 2022). However, beliefs surrounding other causes of death that are salient to the public may have influenced reported perceptions of risk. For example, of all deaths registered in 2019 in England and Wales, 13% were due to dementia and Alzheimer's disease (Office for National Statistics, 2020). Despite the increasing prevalence of this cause of death in the UK, it is not classed as an avoidable death. Given our focus on the relationships between perceptions of risk, health behaviours and the reduction of avoidable deaths, we chose not to include this cause of death in our survey. Future research may look to include a broader range of causes of death when studying public perceptions, as well as to investigate public knowledge concerning which health risks are or are not personally avoidable.

Conclusion

Our findings suggest that people perceive cancer-related deaths to be both likely to happen to them, and largely beyond their control. This has implications for preventative health behaviours, as the UMRH suggests that those who believe they are more likely to die as a result of factors that are beyond their control should be less motivated to engage in positive health behaviours. Ironically, this reduced motivation to behave healthfully may also increase the risk of cancer, thus perpetuating a feedback loop. We suggest that more can be done by public health communicators to emphasise the lifestyle and behavioural changes that individuals can make to reduce their general cancer risk.

Perceptions of control over specific causes of death were found not to be strong predictors of overall levels of perceived uncontrollable mortality risk. We recommend that future studies investigate the roles that developmental, cultural, and informational environments play in driving perceptions of control over risk. The exception to this trend was perceptions of control over cardiovascular disease, which was negatively associated with overall PUMR. Risk of death due to cardiovascular disease was considered controllable, relative to other risks, yet was still rated the second most likely cause of individual death. We suggest that further research is needed to study and unravel the numerous neighbourhood effects that may discourage people from maintaining a healthy heart.

Finally, our findings offer support for the *primary bias* in risk perceptions, by investigating a previously unexplored UK population with respect to the prevalence of avoidable death. The portion of UK avoidable deaths due to drugs and alcohol was substantially overestimated by our sample, despite being considered the least likely cause of personal death. Health professionals should work to counteract the tendency to underestimate alcohol consumption and we call for greater journalistic responsibility when reporting health risks to the public.

Acknowledgements

We would like to thank Professor Thomas Pollet and Dr Santosh Vijaykumar for their thoughtful comments and suggestions that helped to enhance this article.

Funding

We received support from Prolific and the European Human Behaviour and Evolution Society for the development and delivery of the survey questionnaire associated with this study.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Research Transparency and Reproducibility

All data associated with this submission will be made available as part of the Open Science Framework (OSF; osf.io/dgwna).

References

Aka, A., & Bhatia, S. (2022). Machine Learning Models for Predicting, Understanding, and Influencing Health Perception. *Journal of the Association for Consumer Research*, *7*(2), 142-153.

An, R., Yang, Y., Hoschke, A., Xue, H., & Wang, Y. (2017). Influence of neighbourhood safety on childhood obesity: a systematic review and meta-analysis of longitudinal studies. *Obesity reviews*, *18*(11), 1289-1309.

Blackadar, C. B. (2016). Historical review of the causes of cancer. *World journal of clinical oncology*, *7*(1), 54.

Blanchard, D. C., Griebel, G., Pobbe, R., & Blanchard, R. J. (2011). Risk assessment as an evolved threat detection and analysis process. *Neuroscience & Biobehavioral Reviews*, *35*(4), 991-998.

Brown, D. K., & Midberry, J. (2022). Social media news production, emotional Facebook reactions, and the politicization of drug addiction. *Health Communication*, *37*(3), 375-383.

Brown, R., Coventry, L., & Pepper, G. (2021a). COVID-19: the relationship between perceptions of risk and behaviours during lockdown. *Journal of public health*, 1-11.

Brown, R., Coventry, L., & Pepper, G. (2021b). Information seeking, personal experiences, and their association with COVID-19 risk perceptions: demographic and occupational inequalities. *Journal of risk research*, *24*(3-4), 506-520. https://doi.org/10.1080/13669877.2021.1908403

Brown, R., Sillence, E., & Pepper, G. (2022). A qualitative study of perceptions of control over potential causes of death and the sources of information that inform perceptions of risk. *Health Psychology and Behavioral Medicine*, *10*(1), 632-654. https://doi.org/10.1080/21642850.2022.2104284

Brown, R., Sillence, E., & Pepper, G. (2023). Individual characteristics associated with perceptions of control over mortality risk and determinants of health effort. *'Manuscript In Preparation'*.

Brown, R. D., & Pepper, G. (2023). The Uncontrollable Mortality Risk Hypothesis of Health Behaviour: a Position Paper *'Manuscript In Preparation'*. osf.io/py7dw

Bui, L., Mullan, B., & McCaffery, K. (2013). Protection motivation theory and physical activity in the general population: A systematic literature review. *Psychology, health & medicine*, *18*(5), 522-542.

Cabinet Office. (2020). *National Risk Register 2020*. UK Government Retrieved from https://www.gov.uk/government/publications/national-risk-register-2020

Cancer Research UK. (2018a). *Lifetime risk of cancer*. https://www.cancerresearchuk.org/health-professional/cancer-statistics/risk/lifetime-risk#heading-Zero

Cancer Research UK. (2018b). *Science Surgery: 'How quickly do tumours develop?'*. https://news.cancerresearchuk.org/2018/10/18/science-surgery-how-quickly-do-tumours-develop/#:~:text=Scientists%20have%20found%20that%20for,really%20slow%2C%E2%80%9D%20says%20Graham.

Clerk, A. M. (2021). Beware of Neglect of Non-COVID Patients in COVID Era. *Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine*, *25*(8), 837.

Curtin, K. D., Berry, T. R., Courneya, K. S., McGannon, K. R., Norris, C. M., Rodgers, W. M., & Spence, J. C. (2018). Investigating relationships between ancestry, lifestyle behaviors and perceptions of heart disease and breast cancer among Canadian women with British and with South Asian ancestry. *European Journal of Cardiovascular Nursing*, *17*(4), 314-323.

Darr, A., Astin, F., & Atkin, K. (2008). Causal attributions, lifestyle change, and coronary heart disease: illness beliefs of patients of South Asian and European origin living in the United Kingdom. *Heart & Lung*, *37*(2), 91-104.

Drews, S., Savin, I., Van Den Bergh, J. C., & Villamayor-Tomás, S. (2022). Climate concern and policy acceptance before and after COVID-19. *Ecological Economics*, *199*, 107507.

Durkin, S., Brennan, E., & Wakefield, M. (2012). Mass media campaigns to promote smoking cessation among adults: an integrative review. *Tobacco control*, *21*(2), 127-138.

Ellis, P. D. (2010). *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results*. Cambridge university press.

Eurofound. (2017). *Sixth European Working Conditions Survey – Overview report (2017 update)* (Publications Office of the

European Union, Issue. https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1634en.pdf

Flowerdew, R., Manley, D. J., & Sabel, C. E. (2008). Neighbourhood effects on health: does it matter where you draw the boundaries? *Social Science & Medicine*, *66*(6), 1241-1255.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of applied social psychology*, *30*(2), 407-429.

Galster, G. C. (2012). The mechanism (s) of neighbourhood effects: Theory, evidence, and policy implications. In *Neighbourhood effects research: New perspectives* (pp. 23-56). Springer.

Garnett, C., Crane, D., West, R., Michie, S., Brown, J., & Winstock, A. (2015). Normative misperceptions about alcohol use in the general population of drinkers: a cross-sectional survey. *Addictive behaviors*, *42*, 203-206.

Gierlach, E., Belsher, B. E., & Beutler, L. E. (2010). Cross-cultural differences in risk perceptions of disasters. *Risk Analysis: An International Journal*, *30*(10), 1539-1549.

Graham, C., Griffiths, B., Tillotson, S., & Rollings, C. (2013). Healthy living? By whose standards? Engaging mental health service recipients to understand their perspectives of, and barriers to, healthy living. *Psychiatric Rehabilitation Journal*, *36*(3), 215.

Hakes, J. K., & Viscusi, W. K. (2004). Dead reckoning: Demographic determinants of the accuracy of mortality risk perceptions. *Risk Analysis: An International Journal*, *24*(3), 651-664.

Hebbali, A. (2020). *olsrr: Tools for Building OLS Regression Models. R package version 0.5.3*. In https://CRAN.R-project.org/package=olsrr

Hertzog, M. A. (2008). Considerations in determining sample size for pilot studies. *Research in nursing & health*, *31*(2), 180-191.

Holakouie-Naieni, K., & Nematollahi, S. (2020). Re: Neglected major causes of death much deadlier than COVID-19. *Journal of Research in Health Sciences*, *20*(2), e00482.

Hope, R. (2013). *Rmisc: Rmisc: Ryan Miscellaneous. R package version 1.5.* In https://CRAN.R-project.org/package=Rmisc

Kassambara, A. (2019). *ggcorrplot: Visualization of a Correlation Matrix using 'ggplot2'. R package version 0.1.3.* In https://CRAN.R-project.org/package=ggcorrplot

Kassambara, A., & Mundt, F. (2021). Factoextra: Extract and Visualize the Results of Multivariate Data Analyses; R Package Version 1.0. 7. 2020. In.

Key, T. J., Bradbury, K. E., Perez-Cornago, A., Sinha, R., Tsilidis, K. K., & Tsugane, S. (2020). Diet, nutrition, and cancer risk: what do we know and what is the way forward? *Bmj*, *368*.

Komsta, L., & Novomestky, F. (2015). *moments: Moments, cumulants, skewness, kurtosis and related tests. R package version 0.14.* In https://CRAN.R-project.org/package=moments

Koob, G. F., & Volkow, N. D. (2016). Neurobiology of addiction: a neurocircuitry analysis. *The lancet psychiatry*, *3*(8), 760-773.

Kyriakidou, M., Morani, M., Soo, N., & Cushion, S. (2021). Reporting from the front line: the role of health workers in UK television news reporting of COVID-19. In *Communicating COVID-19* (pp. 41-58). Springer.

Liang, B., & Wang, Y. (2021). Conceptualizing an ecological model of Google search and Twitter data in public health. In *Empowering Human Dynamics Research with Social Media and Geospatial Data Analytics* (pp. 185-202). Springer.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., & Combs, B. (1978). Judged frequency of lethal events. *Journal of experimental psychology: Human learning and memory*, *4*(6), 551.

Long, J. (2020). interactions: Comprehensive, user-friendly toolkit for probing interactions (1.1. 3)[Computer software]. In.

Macmillan, I. R. (2000). *Growing up scared, the effects of violent victimization in adolescence on adult socio-economic attainment*

Maier, M. (2015). *`R: Einführung durch angewandte Statistik"_. R package version 0.9.3*. In http://CRAN.R-project.org/package=REdaS

Meier, P. S. (2010). Polarized drinking patterns and alcohol deregulation: trends in alcohol consumption, harms and policy: United Kingdom 1990–2010. *Nordic Studies on Alcohol and Drugs*, *27*(5), 383-408.

Mumenthaler, C., Renaud, O., Gava, R., & Brosch, T. (2021). The impact of local temperature volatility on attention to climate change: Evidence from Spanish tweets. *Global environmental change*, *69*, 102286.

Murji, K. (2020). The agony and the ecstasy: Drugs, media and morality. In *The Control of Drugs and Drug Users* (pp. 69-85). CRC Press.

Nettle, D. (2010). Why are there social gradients in preventative health behavior? A perspective from behavioral ecology. *PLoS One*, *5*(10), e13371.

O'Guinn, T. C., & Wells, W. D. (1989). Subjective Discretionary Income. *Marketing Research*, *1*(1).

Office for National Statistics. (2020). *Dementia and Alzheimer's disease deaths including comorbidities, England and Wales: 2019 registrations*. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/dementiaandalzheimersdiseasedeathsincludingcomorbiditiesenglandandwales/2019registrations

Office for National Statistics. (2021). *Data collection changes due to the pandemic and their impact on estimating personal well-being* (People, population and community, Issue. https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/methodologies/datacollectionchangesduetothepandemicandtheirimpactonestimatingpersonalwellbeing#sample-composition

Office for National Statistics. (2022). *Avoidable mortality in Great Britain: 2020*. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/causesofdeath/bulletins/avoidablemortalityinenglandandwales/2020

Orsini, M. M. (2015). Media narratives and drug prohibition: A content analysis of themes and strategies promoted in network news coverage, 2000-2013.

Pepper, G. V., & Nettle, D. (2014a). Out of control mortality matters: the effect of perceived uncontrollable mortality risk on a health-related decision. *PeerJ*, *2*, e459.

Pepper, G. V., & Nettle, D. (2014b). Perceived extrinsic mortality risk and reported effort in looking after health. *Human Nature*, *25*(3), 378-392.

Pepper, G. V., & Nettle, D. (2014c). Socioeconomic disparities in health behaviour: An evolutionary perspective. In *Applied evolutionary anthropology* (pp. 225-243). Springer.

Pepper, G. V., & Nettle, D. (2017a). The behavioural constellation of deprivation: Causes and consequences. *Behavioral and Brain Sciences*, *40*, e314.

Pepper, G. V., & Nettle, D. (2017b). Strengths, altered investment, risk management, and other elaborations on the behavioural constellation of deprivation. *Behavioral and Brain Sciences*, *40*, e346.

Peterson, C. H., Peterson, N. A., & Powell, K. G. (2017). Cognitive Interviewing for Item Development: Validity Evidence Based on Content and Response Processes. *Measurement and Evaluation in Counseling and Development*, *50*(4), 217-223. https://doi.org/10.1080/07481756.2017.1339564

Peterson, R. (2021). Finding Optimal Normalizing Transformations via bestNormalize, R J., 13, 310–329. In.

Pilar, M. R., Eyler, A. A., Moreland-Russell, S., & Brownson, R. C. (2020). Actual Causes of Death in Relation to Media, Policy, and Funding Attention: Examining Public Health Priorities. *Frontiers in public health*, *8*, 279.

Poorolajal, J. (2020). Neglected major causes of death much deadlier than COVID-19. *Journal of Research in Health Sciences*, *20*(2), e00478.

Popova, L. (2012). The extended parallel process model: Illuminating the gaps in research. *Health Education & Behavior*, *39*(4), 455-473.

Prins, R. G., Kamphuis, C. B. M., van Empelen, P., Beenackers, M. A., Brug, J., Mackenbach, J. P., & Oenema, A. (2013). Explaining socio-demographic differences in disengagement from sports in adolescence. *European journal of public health*, *23*(5), 811-816. https://doi.org/10.1093/eurpub/cks188

Proctor, R. N. (2012). The history of the discovery of the cigarette–lung cancer link: evidentiary traditions, corporate denial, global toll. *Tobacco control*, *21*(2), 87-91.

R Core. (2021). Core R: a language and environment for statistical computing. *R Foundation for Statistical Computing, Vienna*.

Rader, C., Comish, R., & Burckel, D. (2011). The effectiveness of single vs multiple-item measures of subjective discretionary income in predicting family purchasing behavior Proceedings of ASBBS Las Vegas.

Revelle, W. (2021). psych: Procedures for Personality and Psychological Research (Version R package version 2.0. 12). Northwestern University, Evanston, Illinois. In.

Ritchie, H., & Roser, M. (2018). Causes of death. *Our World in Data*.

Roazzi, A., Attili, G., Pentima, L. D., & Toni, A. (2016). Locus of control in maltreated children: the impact of attachment and cumulative trauma. *Psicologia: Reflexão e Crítica*, *29*.

Rogers, R., Cacioppo, J., & Petty, R. (1983). Social psychophysiology: a sourcebook. In (pp. 153-176): Guilford Press New York, NY.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change1. *The Journal of Psychology*, *91*(1), 93-114.

Selker, R., Love, J., Dropmann, D., & Moreno, V. (2021). jmv: The 'jamovi' Analyses. R package version 2.0. https://CRAN.R-project.org/package=jmv

Sievert, C. (2020). Chapman and Hall/CRC; 2020. Interactive Web-Based Data Visualization with R, plotly, and shiny. In.

Slovic, P. (1978). The psychology of protective behavior.
Slovic, P. E. (2000). The perception of risk. In. Earthscan publications.
Smith, L., & Foxcroft, D. (2009). Drinking in the UK. *An exploration of trends. York: Joseph Rowntree Foundation*.
Stanley, D. (2021). *apaTables: Create American Psychological Association (APA) Style Tables. R package version 2.0.8.* In https://cran.r-project.org/package=apaTables
Tuohimaa, H. (2014). In search of an empowering and motivating personal wellbeing pathway for Finnish heart patients. *SpringerPlus*, *3*(1), 1-14.
United Nations. (2022). *The UN and the war in Ukraine: key information* (Everything you need to know about the UN response to the war in Ukraine., Issue. https://unric.org/en/the-un-and-the-war-in-ukraine-key-information/
Usher-Smith, J. A., Silarova, B., Ward, A., Youell, J., Muir, K. R., Campbell, J., & Warcaba, J. (2017). Incorporating cancer risk information into general practice: a qualitative study using focus groups with health professionals. *British Journal of General Practice*, *67*(656), e218-e226.
Wang, C., O'Neill, S. M., Rothrock, N., Gramling, R., Sen, A., Acheson, L. S., . . . Ruffin, M. T. (2009). Comparison of risk perceptions and beliefs across common chronic diseases. *Preventive medicine*, *48*(2), 197-202. https://doi.org/https://doi.org/10.1016/j.ypmed.2008.11.008
West, R., & Brown, J. (2013). Theory of addiction.
Whitacre, P. T., Tsai, P., & Mulligan, J. (2009). The public health effects of food deserts. Workshop Summary,
White, A. E., Kenrick, D. T., Li, Y. J., Mortensen, C. R., Neuberg, S. L., & Cohen, A. B. (2012). When nasty breeds nice: Threats of violence amplify agreeableness at national, individual, and situational levels. *Journal of personality and social psychology*, *103*(4), 622.
Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L., François, R., . . . Hester, J. (2020). Welcome to the Tidyverse. J Open Source Softw. 2019; 4: 1686. In.
Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communications Monographs*, *59*(4), 329-349.
Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior*, *27*(5), 591-615.
Wong, C. C., Mill, J., & Fernandes, C. (2011). Drugs and addiction: an introduction to epigenetics. *Addiction*, *106*(3), 480-489.
YouGov. (2021). *Research Q&A's*. yougov.co.uk/about/panel-methodology/research-qs/
Young, E. S., Frankenhuis, W. E., & Ellis, B. J. (2020). Theory and measurement of environmental unpredictability. *Evolution and Human Behavior*, *41*(6), 550-556. https://doi.org/https://doi.org/10.1016/j.evolhumbehav.2020.08.006
Zeileis, A., & Hothorn, T. (2020). Diagnostic checking in regression relationships. R News. 2002; 2/3: 7-10. In.

Supplement

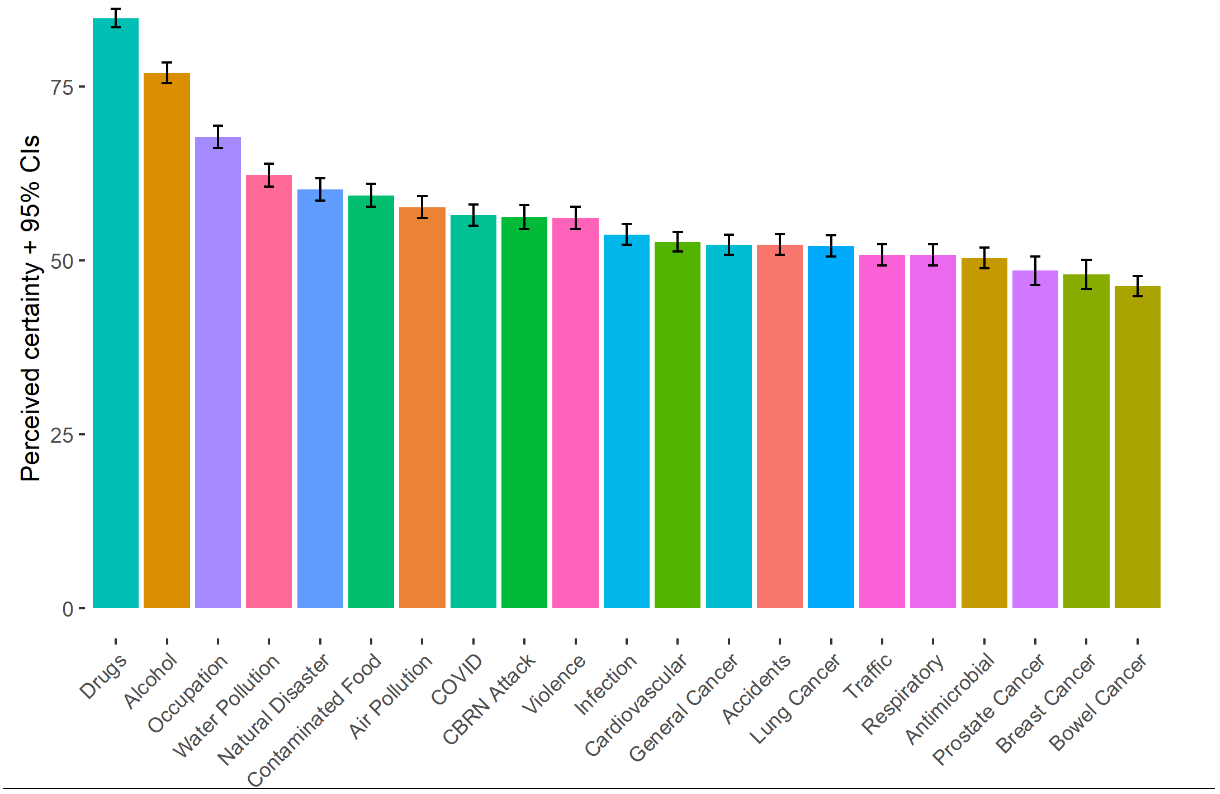

Figure S1. Perceived certainty of risk estimation for each cause of death.

Bars represent mean scores out of 100 for each cause of death, with 95% confidence intervals. N = 1,463 for all causes except breast cancer (n = 742 females) and prostate cancer (n = 714 males).

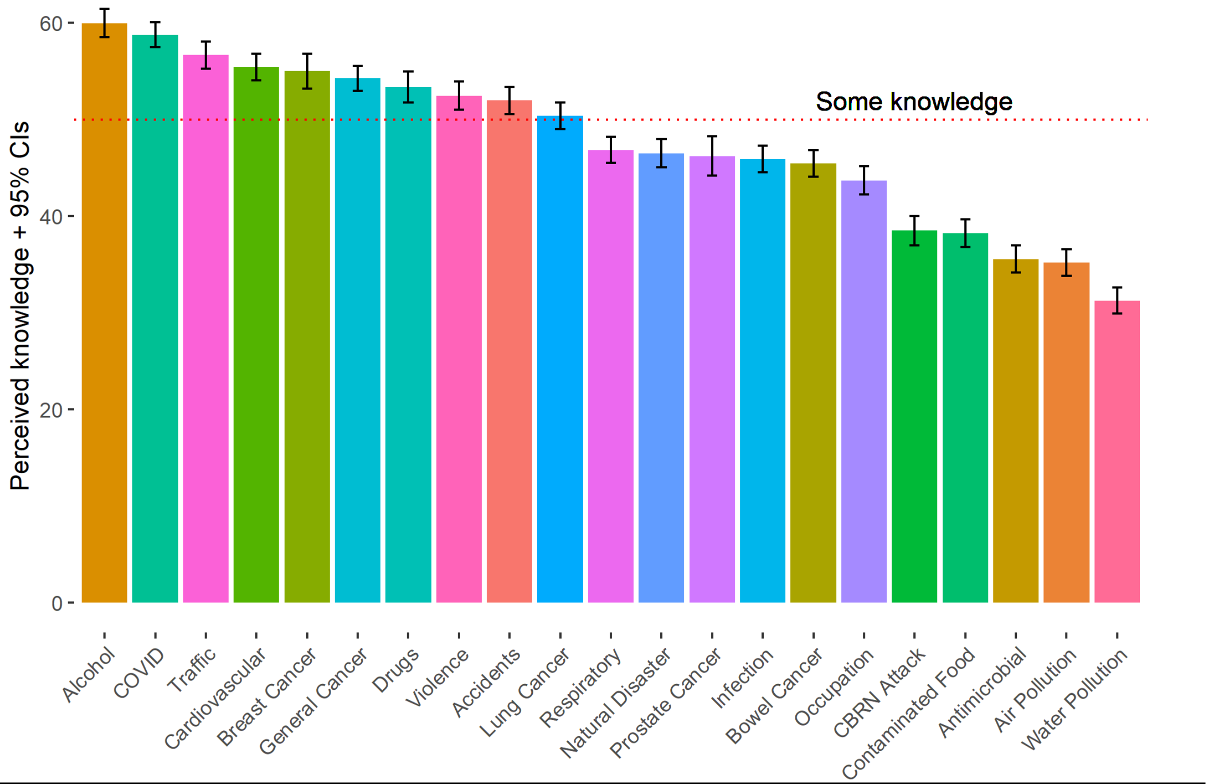

Figure S2. Perceived knowledge of risk for each cause of death.

Bars represent mean scores out of 100 for each cause of death, with 95% confidence intervals. N = 1,463 for all causes except breast cancer (n = 742 females) and prostate cancer (n = 714 males).

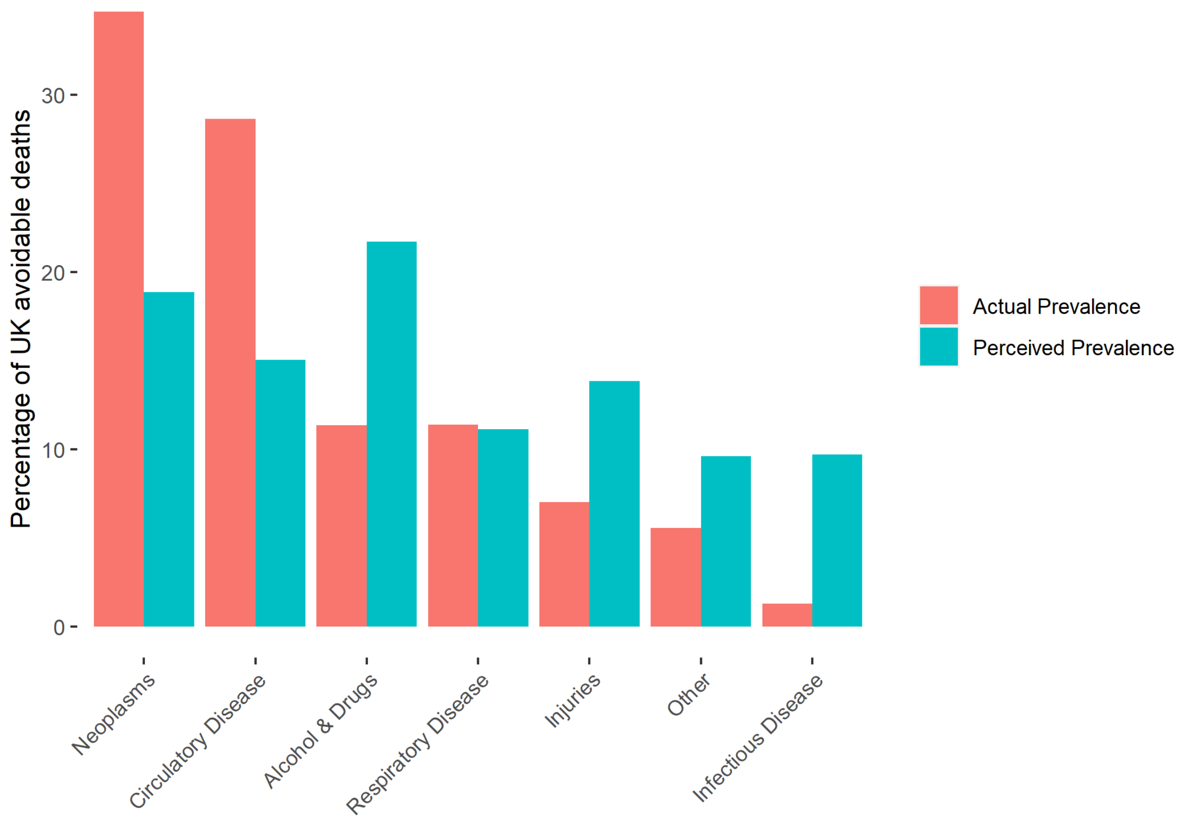

Figure S3. Comparison of perceived and actual prevalence of avoidable deaths in the UK.

Table S1. Regression analyses showing socio-demographic predictors of perceived uncontrollable mortality risk.

Predictor	*b*	*b* 95% CI [LL, UL]	sr^2	sr^2 95% CI [LL, UL]	Fit
(Intercept)	42.11**	[34.29, 49.93]			
Age	0.01	[-0.06, 0.09]	.00	[-.00, .00]	
Gender(Woman)	-1.17	[-3.20, 0.86]	.00	[-.00, .01]	
Education	0.10	[-0.20, 0.39]	.00	[-.00, .00]	
Subjective Discretionary Income	-0.73**	[-1.17, -0.29]	.01	[-.00, .02]	
Discretionary Income	-0.00**	[-0.01, -0.00]	.01	[-.00, .02]	
Perceived Neighbourhood Safety	-1.72**	[-2.66, -0.78]	.01	[-.00, .03]	
Self-reported Occupational Exposure	0.08	[-0.04, 0.19]	.00	[-.00, .01]	
					R^2 = .069** 95% CI [.04,.09]

Note. A significant b-weight indicates the semi-partial correlation is also significant. b represents unstandardized regression weights. sr2 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.*