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Comparison of coping responses to SARS-CoV-2 by people with and without existing health conditions in the UK

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ABSTRACT

Background

SARS-CoV-2 and the resulting national movement restrictions (lockdowns) have had a profound impact on the health of people in the UK. Many people with pre-existing conditions have had to 'shield' themselves due to the high-risk of SARS-CoV-2. This population commonly present with poorer mental health and more health-threatening behaviours associated with the burden of disease. Little is currently known about how the threat of SARS-Cov-2 and the attempts to prevent transmission has impacted on the health, well-being and health behaviours of these vulnerable individuals.

Objective

To investigate impact of SARS-CoV-2 on self-reported mood, coping and health behaviours of people living with existing health conditions in the UK to understand how to improve coping responses to the threat of SARS-CoV-2.

Methods

A cross-sectional online survey involving UK adults (18 years +). Multivariable linear regression and sequential multiple mediation analysis were used to estimate differences in average scores for active and avoidant coping responses scores due to pre-existing health conditions, and to investigate the extent to which these differences are explained by differences in perceptions, beliefs, concerns and mood.

Results

People with pre-existing physical and especially mental health conditions reported poorer health and used more avoidant coping compared to healthy participants. Under some strong untestable assumptions, we estimate that experiencing low mood or concern related to SARS-CoV-2 mostly explained the relationship between existing health conditions and avoidant coping.

Conclusion

Psychological support and interventions including behaviour change is required to mitigate the psychological burden of the SARS-CoV-2 pandemic and increase autonomy in people with and without pre-existing conditions during this highly uncertain time. Psychologists are well-placed to support clinicians and people with existing health conditions to minimise the psychological impact of SARS-CoV-2, in order to alleviate the subsequent strain on healthcare services.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first theory led study in the UK to investigate cognitive, emotional and behavioural responses to the threat of SARS-CoV-2 among people who are vulnerable due to living with physical and mental health conditions.
- The rapid launch of the survey allowed data to be collected in real time but prohibited the validation of survey items.
- The majority of participants identified as being of white ethnic origin limiting the generalizability of the findings to other ethnic groups, who we know to be disproportionately affected by SARS-CoV-2.
- The study was conducted by a multidisciplinary team with backgrounds in health psychology, statistics and nursing and a member of the public.

INTRODUCTION

On 23rd March 2020, the UK government imposed a national movement restriction (lockdown) to control the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This caused major disruption to the economy, public systems and signalled a serious potential threat to people's health and well-being.[1] Responses to SARS-CoV-2 differed between countries and individuals differed in their reactions depending on the perception of this threat to health.

Perception of a health threat drives subsequent emotional and behavioural responses to it (Common Sense Model of Self-Regulation [CSM]).[2] Thus, what people think and feel about SARS-CoV-2 affects how they cope with it. We know that avoidant coping, including for example excessive alcohol intake or unhealthy, so called 'comfort' eating, can adversely affect health outcomes.[3] These health-threatening behaviours perpetuate the risk of serious non-communicable diseases, including cardiovascular and metabolic diseases and some cancers.[4] Smoking[5] and being overweight or obese are associated with increased risk of hospitalization, severe disease progression[6] and death due to SARS-CoV-2.[7] People living with existing health conditions (EHCs) are generally more susceptible to poor health and behavioural outcomes,[8] which could worsen their condition(s) and further reduce their ability to cope with the threat of SARS-CoV-2.[9]

Higher rates of suicidal ideation, stress related to SARS-CoV-2, anxiety and depression were evident among people with a mental EHC in the early stages of lockdown,[10] and the presence of an EHC predicted worse mental health.[11] This suggests that individuals with EHCs, mental illnesses especially,[10] may be particularly vulnerable to poorer psychological outcomes related to SARS-CoV-2 and may require additional psychological support,[12 13] but these studies do not explain the psychological mechanisms underpinning health behaviours. A recent study showed that anxiety related to SARS-CoV-2 reduced general health and peoples' ability to cope with stress during the global pandemic,[14] though most participants (86%) reported no EHCs, limiting the generalizability of the findings.

Few studies have investigated how the threat of SARS-CoV-2 impacts on people with EHCs.[9] Umucu and Lee (2020)[15] found that perceived stress related to SARS-CoV-2 was associated with maladaptive coping in people with chronic conditions and disabilities in the USA. However, their sample was small and coping responses between people with mental and physical EHCs were not compared. Comparing coping responses between groups and identifying the underlying psychological factors is essential for designing appropriate support for people with EHCs to cope with SARS-CoV-2.

We investigated the impact of SARS-CoV-2 on self-reported beliefs, mood and health behaviours of people in the UK living with one or more existing physical or mental EHCs in order to inform future interventions.

METHODS

Design

A cross-sectional online survey including free-text response boxes.

Participants

Adults aged 18 years and over living in the UK.

Materials

An online survey was developed comprising four sections: (1) participant demographics; (2) personal beliefs; (3) emotions; and (4) behaviour towards the threat of SARS-CoV-2. Survey items in these sections were based on some, but not all, concepts from existing theories and models, including the CSM,[2] the Transactional Model of Stress and Coping,[16] the Health Belief Model,[17] and Protection Motivation Theory.[18] The key theoretical concepts and related survey items are summarised in Supplementary Material 1.

Items were based on a five-point Likert scale ranging from 'completely disagree' to 'completely agree'. A free-text box was included at the end of each section for participants to provide additional comments.

Procedure

Ethics approval was obtained from School of Healthcare Sciences, Cardiff University (SREC: 637).

The snowball sampling technique was adopted to recruit participants through existing contacts via email and WhatsApp, as well as the websites and social media platforms (Twitter, Facebook, Instagram) of Cardiff University, HealthWise Wales (a research participant database) and Hywel Dda Health Board.

Survey completers were encouraged to share the survey. Informed consent was obtained prior to participants completing the survey. The survey was open from 8th April to 14th June 2020.

Patient and public involvement

A member of the public was involved in the analysis and interpretation of the free-text responses.

Analysis

We were primarily concerned with the extent to which EHCs affect coping and health behaviours, and the extent to which any effect is mediated through and moderated by different perceptions and emotions (Supplementary Material 2). Age, gender, ethnic group and socio-economic position (proxied by educational qualifications and employment status) were considered as confounders. Variable definitions can be found in Supplementary Material 3.

Missing data

The confounder and exposure data were completely observed. There were small amounts of item non-response in all other variables, ranging from 0.1% to 2%, with a mean non-response proportion of 0.4% per item. However, due to the non-monotone pattern of non-response, 1,494 (16%) of the participants were missing at least one of the relevant items. A single stochastic regression imputation using chained equations [19] was performed (Supplementary Material 4).

Overall effect: What is the effect of EHCs on Coping and Health Behaviours?

We fitted two multivariable linear regression analyses to the two coping outcomes (active and avoidance) with the exposure and confounders included as predictors. The exposure, EHC, was

categorised into three groups: (1) no EHC; (2) at least one physical EHC but no mental EHC; and (3) a mental EHC, including those with both physical and mental EHCs. In a secondary analysis, to check if any differences identified in the first analysis were dominated by one or a small number of components, we repeated the above for each component of the active and avoidance coping scores separately (and not adjusting for each other). The estimated mean differences in the coping outcomes between EHC groups, adjusted for age, gender, ethnicity, education and employment, together with their 95% confidence intervals, are reported.

Mediation: To what extent is the effect of EHCs on Coping and Health Behaviours mediated through threat perception and feelings?

A sequential multiple mediator analysis [20] was performed to investigate the extent to which threat perception and emotions mediated the effect of EHCs on coping and health behaviours. The mediators were split into two groups (see Supplementary Material 2) and an estimation-by-simulation approach was used to partition the estimated overall effect of EHCs on the coping outcomes first into (A) an indirect effect via some or all of the mediators and (B) a direct effect not via any of the mediators considered, and second to partition the indirect effect (A) into (A1) the indirect effect through the first set of mediators and (A2) the indirect effect through the second set of mediators, where any effect through both sets in sequence is included in (A1) (see Supplementary Material 5) for the full details, including the strong no unmeasured confounding assumptions on which this partitioning relies).

Effect modification: To what extent is the effect of EHCs on Coping and Health Behaviours modified by threat perception and feelings?

Effect modification was investigated directly from the multivariable linear models, with product terms added (see Supplementary Material 6).

RESULTS

There were 9,110 respondents; 4,377 (48%) reported at least one EHC, of which 874 (10%) reported having two or more EHCs, and 715 (8%) report having an existing mental health condition. Sample characteristics are presented in Table 1.

Table 1: Sample characteristics

	n (%)
Total	9110
Survey	
Cardiff University	3016 (33.1)
Healthwise Wales	6076 (66.7)
Hywel Dda	18 (0.2)
Country	
England	52 (0.8)

Wales	6139 (99)
Scotland	9 (0.1)
Age (Years)	
18 – 30	807 (8.9)
31 – 40	1111 (12.2)
41 – 50	1322 (14.5)
51 – 60	1898 (20.8)
61 – 70	2472 (27.1)
71 – 80	1337 (14.7)
81+	150 (1.6)
Gender	
Male	2791 (30.6)
Female	6298 (69.1)
Other	15 (0.3)
EHCs	
Cardiovascular	791
Respiratory	1103
Diabetes	579
Cancer	235
Dementia	4
Mental illness	715
Pregnancy	64
Other	1931
Ethnicity	
White/White British	8783 (96.4)
Black/African/Caribbean/Black British	34 (0.4)
Asian/Asian British	101 (1.1)
Mixed/Multiple Ethnic Groups	87 (1)
Other Ethnic group	105 (1.2)
Highest qualification	
Usual high school qualifications in your country at age 16 (e.g. GCSE, O-level)	1260 (13.8)

Usual high school qualifications in your country at age 18 (E.g. AS level, A-Level)	828 (9.1)
A college or university diploma or degree	3945 (43.3)
A higher degree or professional qualification (e.g. a Doctorate or Masters level degree)	2543 (27.9)
None of these qualifications	318 (3.5)
Other	140 (1.5)
Normally occupied	
Full-time	3379
Part-time	1595
Unemployed, seeking work	67
Unemployed, not seeking work	281
Full-time education	340
Part-time education	102
Volunteer	436
Homemaker	256
Retired	3387

Participants without EHCs tended to be younger, female, from an ethnic group other than white, educated to college- or university-level, and in (full- or part-time) employment or education. All of these findings are significant at $p<0.001$ (chi squared test), though some differences were small (Supplementary Material 7).

After adjusting for cofounding variables (age, gender, ethnic group, education and employment) having an EHC is estimated to decrease active coping scores but increase avoidance coping scores. Those with at least one physical EHC (but no mental EHC) had an active coping score on average 1.46 lower (95%CI 1.11-1.80) and an avoidance coping score on average 1.11 higher (95% CI 0.88-1.34) than those without an EHC. The effect of having a mental EHC was greater than having a physical EHC. Those with a mental EHC (including those with both a mental and physical EHC) had an active coping score on average 3.16 lower (95%CI 2.54-3.78) and an avoidance coping score on average 3.06 higher (95% CI 2.65-3.48) than those without an EHC. The observed standard deviations of active and avoidance coping score variables in this sample (7.9 and 5.5, respectively), indicate the absolute magnitude of the significant effects were relatively small (Table 2).

Table 2: Results of linear regression models for active coping (LHS) and avoidance coping (RHS) on the categorical exposure EHC (none/at least one physical EHC but no mental EHC/mental EHC) and confounders

	Active Coping Score				Avoidance Coping Score			
	Estimated coefficient	95% CI		p-value	Estimated coefficient	95% CI		p-value
Existing health condition (EHC) (baseline = none)								
>=1 physical but no mental EHC	-1.46	-1.80	-1.11	0.00	1.11	0.88	1.34	0.00
Mental EHC	-3.16	-3.78	-2.54	0.00	3.06	2.65	3.48	0.00
Age (baseline = 18-30 yrs)								
31 to 40 yrs	0.25	-0.47	0.97	0.50	-0.43	-0.94	0.05	0.08
41 to 50 yrs	1.11	0.41	1.82	0.00	-1.18	-1.66	-0.71	0.00
51 to 60 yrs	1.38	0.69	2.06	0.00	-2.31	-2.76	-1.85	0.00
61 to 70 yrs	1.66	0.90	2.42	0.00	-3.31	-3.82	-2.80	0.00
71 to 80 yrs	1.27	0.39	2.15	0.01	-3.71	-4.30	-3.12	0.00
81+ yrs	0.34	-1.12	1.79	0.65	-3.66	-4.64	-2.69	0.00
prefer not to say	2.27	-1.97	6.52	0.29	-1.15	-3.99	1.70	0.43
Gender (baseline = male)								
Female	1.50	1.14	1.85	0.00	1.22	0.98	1.45	0.00
Other	-1.03	-4.36	2.30	0.55	-0.44	-2.67	1.79	0.70
Ethnic group (baseline = white)								
Non-white	0.44	-0.42	1.31	0.31	0.12	-0.46	0.70	0.69
Highest educational qualification (baseline = none/other)								
School-level	0.39	-0.34	1.12	0.29	-0.49	-0.99	-0.00	0.05
College- or University-level	1.99	1.30	2.67	0.00	-1.44	-1.90	-0.98	0.00

Current employment status (baseline = Full-time paid work)								
Part-time paid work	-0.03	-0.50	0.44	0.91	-0.29	-0.60	0.03	0.07
in education	-0.48	-1.44	0.48	0.33	-0.57	-1.21	0.07	0.08
Retired	-1.92	-2.49	-1.35	0.00	-1.16	-1.54	-0.79	0.00
Unemployed	-6.32	-7.22	-5.41	0.00	-0.36	-0.91	0.24	0.24
Other	-1.47	-2.53	-0.42	0.01	0.14	-0.51	0.84	0.70
Intercept	28.68	27.74	29.61	0.00	13.58	12.95	14.21	0.00

A secondary analysis of each component of active and avoidance coping scores, adjusted for the same confounders, showed that no single component was dominant in driving the results, and the results of some components in each score were in the opposite direction to the majority (Supplementary Material 8).

A sequential multiple mediator analysis was performed to investigate the extent to which threat perception and feelings mediated the effect of EHCs on Coping and Health Behaviours. Supplementary Material 2 displays the mediators of interest.

Table 3 and Supplementary Material 9 show partitioning of active and avoidance coping outcomes into direct and indirect effects, and further into the indirect effects via the two groups of mediators separately; this is done for both the physical and mental EHC exposure comparisons. For the effect of one or more physical EHCs on active coping, almost no effects were mediated. Approximately 54% (95% CI: 43%-65%) of the effect of physical EHCs on avoidance coping was mediated via some or all of the mediators; 46% (95% CI: 36%-56%) via concern and low mood, and 9% (95% CI: 1%-17%) via the first set (including any effects through both sets). For the effect of mental EHC on active coping, an estimated 23% (95% CI: 14%-32%) of the effect was mediated by some or all of the mediators: 11% (95% CI: 3%-19%) via the first set (including any effects through both sets) and 12% (95% CI: 6%-18%) via concern and low mood only. An estimated 72% (95% CI: 63%-82%) of the effect of mental EHC on avoidance coping was mediated via some or all of the mediators; 62% (95% CI: 53%-71%) estimated to be mediated via the second set only and the remaining 10% (95% CI: 6%-14%) via the first set (including any effects through both sets).

Table 3: Results of sequential multiple mediator analyses for active (LHS) and avoidance coping (RHS)

	Active Coping Score				Avoidance Coping Score			
	Estimated effect	95% CI		p-value	Estimated effect	95% CI		p-value
Total effect of Existing health condition (EHC) (baseline = no EHC)								
>=1 physical but no mental EHC	-1.44	-1.81	-1.08	0.00	1.13	0.92	1.33	0.00
Mental EHC	-3.51	-3.87	-2.42	0.00	3.08	2.62	3.54	0.00
Natural direct effect of EHC Not mediated by $\mathbf{M}_1$ nor $\mathbf{M}_2$ (baseline = no EHC)								
At least one physical EHC	-1.61	-1.94	-1.27	0.00	0.52	0.34	0.7	0.00
Mental EHC	-2.43	-3.07	-1.79	0.00	0.85	0.46	1.24	0.00
Natural indirect effect of EHC Mediated by either $\mathbf{M}_1$ or $\mathbf{M}_2$ or both. (baseline = no EHC)								
At least one physical EHC	0.16	-0.01	0.33	0.06	0.61	0.48	0.75	0.00

Mental EHC	-0.72	-1.04	-0.40	0.00	2.23	1.94	2.51	0.00
Natural indirect effect of EHC Mediated by $\mathbf{M}_1$ (and possibly $\mathbf{M}_2$) (baseline = no EHC)								
At least one physical EHC	-0.01	-0.15	0.13	0.88	0.10	0.01	0.19	0.03
Mental EHC	-0.35	-0.60	-0.09	0.01	0.31	0.19	0.44	0.00
Natural indirect effect of EHC Mediated by $\mathbf{M}_2$ only (baseline = no EHC)								
At least one physical EHC	0.17	0.09	0.26	0.00	0.51	0.40	0.63	0.00
Mental EHC	-0.37	-0.57	-0.18	0.00	1.91	1.67	2.16	0.00

Finally, we investigated the extent to which the effects of physical and mental EHCs on active and avoidance coping are modified by low mood, concern, primary threat perception, degrees of belief that scientists, politicians, health care workers and personal faith will overcome the threat, and the degree of fatalism ("what will be will be"). The effect of EHC on coping was remarkably stable across levels of all considered effect modifiers (see Supplementary Material 10).

DISCUSSION

People living with one or more EHCs reported more avoidance than active coping behaviours in response to the threat of SARS-CoV-2 compared to participants with no EHCs. Avoidance coping was more common among people with mental EHCs than physical EHCs. Although based on strong "no unmeasured confounding" assumptions, that demand caution in interpretation, our results suggest that the effects of the mental EHC exposure were mediated to a greater extent than the effects of the physical EHC exposure and that the effects on the avoidance coping outcome were mediated to a greater extent than the effects on the active coping outcome. Most of the mediation occurred via concern and low mood, though the effects of avoidance coping was mediated by primary threat perception, fatalism, personal faith and belief that scientists, politicians and health care workers will overcome the threat. Thus, people with EHCs were more likely to use avoidance coping behaviours due to feeling low or anxious.

In summary, people with EHCs, mental EHCs especially, in our large sample coped less effectively with the threat of SARS-CoV-2 during the imposed pandemic restrictions than people with no EHCs, indicating EHCs further inhibit peoples' ability to cope effectively with the threat and impact of SARS-CoV-2. We did not ask people to be specific which mental EHC they experienced, but it is safe to assume these included anxiety and depressive symptoms, which are the most common mental health conditions.

Individuals living with anxiety and depression symptoms are more likely to use health-threatening behaviours including eating unhealthy food or drinking more alcohol than usual as part of poor coping. Anxiety and depression have further increased as a reaction to the current and on-going threat of SARS-CoV-2 and so the provision of dedicated psychological support incorporating behaviour change is urgently needed to address peoples' coping reactions to the health threat.

What the present study adds

The present study provides insight into the cognitive, emotional and behavioural responses of people with EHCs towards the initial threat of SARS-CoV-2. It builds on the work of Umucu and Lee (2020),[15] demonstrating that avoidance coping was common in a much larger sample of adults with different physical and mental health conditions from across the UK. Furthermore, our study suggests that feeling low and anxious about SARS-CoV-2, partially explains the relationship between living with an EHC and avoidance coping. It highlights the need to improve how clinicians and patients manage mood, coping and address behaviour change in current and future health threats.

Strengths and limitations

To our knowledge, this is the first theory led study in the UK to investigate cognitive, emotional and behavioural responses to the threat of SARS-CoV-2 among people who are vulnerable due to living

with physical and mental EHCs. Whilst the rapid launch of the survey prohibited the validation of survey items, we argue that the capture of this large dataset in real time, strengthens rather than limits this study.

The majority of participants (96.4%) identified as being of white ethnic origin limiting the generalizability of the findings to other ethnic groups, who we know to be disproportionately affected by SARS-CoV-2 due the higher prevalence of comorbidities and deprivation in these populations.[21]

Finally, the causal interpretation of our estimates, both of the overall effects of EHC on coping outcomes, and of the extent to which these are mediated by threat perceptions, beliefs, concerns and low mood, all rely on strong untestable assumptions, mainly that there are no unmeasured common causes of any two or more of the sets of variables considered. For example, there could be other elements of socio-economic position, beyond that captured by employment status and educational qualification, which confound the relationship between EHC and coping, and/or between the mediators and the outcomes or exposure. If these unmeasured components of low SEP increase the probability of having an EHC, decrease coping scores and increase low mood scores, for instance, then both the overall effect of EHCs and the extent to which it is mediated by low mood may be exaggerated.

Practical implications

The present study highlights that people with EHCs may require additional support to cope with future lockdowns and restrictions. Information alone is unlikely to initiate more appropriate coping and behaviour change.[22] Health psychologists and behavioural scientists have expertise in evidence-based approaches to behaviour change as well as being well-placed to advise government leaders and public health practitioners on appropriate approaches that help people with EHCs to cope effectively throughout pandemics.

The SARS-CoV-2 pandemic resulted in major changes to the delivery of healthcare services; the majority of routine consultations are now delivered remotely, allowing continuity of care.[23] Increased demand has further increased the strain on the NHS, lengthening waiting times for mental health services. In addition, many people with EHCs have been unable or reluctant to attend medical appointments during the pandemic for fear of contracting SARS-CoV-2. The NHS will continue to be strained after the pandemic as it contends with this backlog.[24] It is vital that clinicians acknowledge the cognitive, emotional and behavioural factors facing people with EHC, who regularly access healthcare services, but greater financial investment must be provided to psychological services to support them. Addressing the psychological burden may not only help people with EHCs, but may reduce the long-term strain on the NHS.

Future research

We showed living with an EHC plus low mood and anxiety increases avoidance coping in response to SARS-CoV-2. Future research should focus on health behaviour change interventions between the different conditions and specific patient groups. Understanding peoples' personal experiences of coping could inform the design and development of both population health and individual behaviour change interventions that are feasible to implement and acceptable to people with EHCs.

We remind clinicians of the need to routinely address well-being and coping with patients during medical consultations. Additional educational and training may be necessary to enable clinicians to provide basic psychological support to people with EHCs throughout and beyond the SARS-CoV-2 pandemic.

Conclusion

People who live with a pre-existing physical or mental health condition are more likely to display avoidant coping behaviours in response to SARS-CoV-2, especially when experiencing low mood or anxiety. Given that these emotions are common among individuals with EHCs, increased funding and provision for dedicated psychological support in healthcare settings is urgently needed.

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COMPETING INTERESTS
None

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ETHICS APPROVAL
Ethics approval was obtained from School of Healthcare Sciences, Cardiff University.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author, RH, upon reasonable request.

AUTHORS' CONTRIBUTIONS
RH: Study design, data collection, analysis and interpretation, and manuscript drafting. RP: Data analysis and interpretation and manuscript drafting. RD: Data analysis and interpretation and manuscript drafting. JC: Study conception and design, data interpretation and manuscript drafting. OS: Data analysis and interpretation and manuscript drafting. CB: Study concept and design, data collection, analysis and interpretation, and manuscript drafting. All authors were given the opportunity to read and approve the final version of the manuscript for submission.

REFERENCES

1. Varga TV, Bu F, Dissing AS, et al. Loneliness, worries, anxiety, and precautionary behaviours in response to the COVID-19 pandemic: a longitudinal analysis of 200,000 Western and Northern Europeans. *The Lancet Regional Health – Europe* 2021;pre-print doi: https://doi.org/10.1016/j.lanepe.2020.100020
2. Leventhal H, Nerenz DR, Steele DJ. Illness Representations and Coping with Health Threats. In: Baum A, Taylor SE, Singe JE, eds. Handbook of Psychology and Health (Volume IV): Social Psychological Aspects of Health. London: Routledge 1984.
3. Penley JA, Tomaka J, Wiebe JS. The Association of Coping to Physical and Psychological Health Outcomes: A Meta-Analytic Review. *Journal of behavioral medicine* 2002;25(6):551-603. doi: 10.1023/A:1020641400589
4. Organisation WH. *Non-communicable diseases*, 2018.
5. Zvolensky MJ, Garey L, Rogers AH, et al. Psychological, addictive, and health behavior implications of the COVID-19 pandemic. *Behaviour research and therapy* 2020;134:103715-15. doi: 10.1016/j.brat.2020.103715
6. Chang TH, Chou CC, Chang LY. Effect of obesity and body mass index on coronavirus disease 2019 severity: A systematic review and meta-analysis. *Obesity reviews* 2020;21(11):e13089-n/a. doi: 10.1111/obr.13089
7. Popkin BM, Du S, Green WD, et al. Individuals with obesity and COVID-19: A global perspective on the epidemiology and biological relationships. *Obesity reviews* 2020;21(11):e13128-n/a. doi: 10.1111/obr.13128
8. Anderson N, Ozakinci G. Effectiveness of psychological interventions to improve quality of life in people with long-term conditions: rapid systematic review of randomised controlled trials. *BMC Psychology* 2018;6(1):11-11. doi: 10.1186/s40359-018-0225-4
9. Palmer K, Monaco A, Kivipelto M, et al. The potential long-term impact of the COVID-19 outbreak on patients with non-communicable diseases in Europe: consequences for healthy ageing. *Aging clinical and experimental research* 2020;32(7):1189-94. doi: 10.1007/s40520-020-01601-4
10. Fancourt D, Steptoe A, Bu F. Trajectories of anxiety and depressive symptoms during enforced isolation due to COVID-19 in England: a longitudinal observational study. *The Lancet Psychiatry* 2021;8(2):141-49. doi: 10.1016/S2215-0366(20)30482-X
11. Shevlin M, McBride O, Murphy J, et al. Anxiety, depression, traumatic stress and COVID-19-related anxiety in the UK general population during the COVID-19 pandemic. *BJPsych open* 2020;6(6):e125-e25. doi: 10.1192/bjo.2020.109
12. Pedrosa AL, Bitencourt L, Fróes ACF, et al. Emotional, Behavioral, and Psychological Impact of the COVID-19 Pandemic. *Frontiers in psychology* 2020;11:566212-12. doi: 10.3389/fpsyg.2020.566212
13. O'Connor DB, Aggleton JP, Chakrabarti B, et al. Research priorities for the COVID-19 pandemic and beyond: A call to action for psychological science. *The British journal of psychology* 2020;111(4):603-29. doi: 10.1111/bjop.12468
14. Yıldırım M, Akgül Ö, Geçer E. The Effect of COVID-19 Anxiety on General Health: the Role of COVID-19 Coping. *International journal of mental health and addiction* 2021:1-12. doi: 10.1007/s11469-020-00429-3
15. Umucu E, Lee B. Examining the Impact of COVID-19 on Stress and Coping Strategies in Individuals With Disabilities and Chronic Conditions. *Rehabilitation psychology* 2020;65(3):193-98. doi: 10.1037/rep0000328
16. Lazarus RS. Stress, appraisal, and coping. New York: New York : Springer 1984.
17. Hochbaum G, Rosenstock I, Kegels S. H*ealth belief model*. Washington, DC : U.S.: Public Health Service 1952.
18. Rogers RW. A protection motivation theory of fear appeals and attitude change. *The journal of psychology* 1975;91(1):93.

19. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in medicine* 2011;30(4):377-99. doi: 10.1002/sim.4067
20. VanderWeele TJ, Vansteelandt S. Mediation Analysis with Multiple Mediators. *Epidemiol Methods* 2014;2(1):95-115. doi: 10.1515/em-2012-0010
21. Mishra V, Seyedzenouzi G, Almohtadi A, et al. Health Inequalities During COVID-19 and Their Effects on Morbidity and Mortality. *Journal of healthcare leadership* 2021;13:19-26. doi: 10.2147/JHL.S270175
22. West R, Michie S, Rubin GJ, et al. Applying principles of behaviour change to reduce SARS-CoV-2 transmission. *Nature human behaviour* 2020;4(5):451-59. doi: 10.1038/s41562-020-0887-9
23. Ahmed S, Sanghvi K, Yeo D. Telemedicine takes centre stage during COVID-19 pandemic. *BMJ Innovations 2020* 2020;6:252-54. doi: http://dx.doi.org/10.1136/bmjinnov-2020-000440
24. Association BM. *The hidden impact of COVID-19 on patient care in the NHS in England*, 2020.

Supplementary Material

Supplementary Material 1

Table 1. *Covid-19 coping survey items mapped to underlying theoretical models and constructs*

Model / Theory	Theoretical Concept	Survey Item
Common Sense Model	**Identity (perception of threat)**	I believe this is a real threat to mine or my families health I believe this is a real threat to my or my family's well-being I am confident that this threat will not affect me or my family
	Controllability (locus of control)	External Locus of Control: I believe scientists will find a solution to this I believe politicians will get us through this threat I believe Doctors / healthcare staff will get us through this threat I believe what will be will be and I cannot influence things at all I believe my faith will get me through this threat Internal Locus of Control: I think it's important to focus on what I can do for others during this threat
	Consequences	I believe something positive will come from this threat I think things are never going to be the same again Emotional Consequences: I am worried for me or my family now I feel confused about how I feel I am worried for my or my family's future I feel down or depressed about this threat I am concerned about spending so much time on my own I am concerned about spending so much time with my family I feel angry about this threat I feel guilty about this threat I feel optimistic for the future beyond this threat I feel energised in response to this threat

		I don't feel anything different to usual I feel numb or unable to feel anything I feel worried about my health
	Timeline	I believe this is a short term threat I believe this is a long-term threat
	Cause	N/A
Health Belief Model	**Perceived susceptibility**	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being I am confident that this threat will not affect me or my family
	Perceived severity	I believe this whole thing is exaggerated
	Perceived benefits	I believe something positive will come from this threat
	Perceived barriers	N/A
Transactional Model of Stress and Coping	**Primary appraisal (significance)**	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being (mental health) I am confident that this threat will not affect me or my family I believe this whole thing is exaggerated I believe this is a short-term threat I believe this is a long-term threat I believe something positive will come from this threat
	Secondary appraisal (personal resources/ options)	I believe my faith will get me through this threat I think it's important to focus on what I can do for others during this threat I believe what will be will be and I cannot influence things at all
	Coping responses	Active coping: I am focusing on finding the positives every day, more than usual I have taken the initiative to reach out to others physically (e.g. volunteering or caring for neighbours), more than usual

		I have taken the initiative to reach out to others virtually, more than usual I have been physically active, more than usual I have kept to a structured timetable for everyday activities, more than usual I have been practicing psychological techniques such as mindfulness or yoga, more than usual I have decided to learn everything I can about this threat I have taken steps to stay healthy and fit, more than usual I have been doing active work in my community (that could be work community; locality or family or friendship groups), more than usual I have been spending time with family physically, more than usual I am keeping busy with practical, everyday living or work tasks, more than usual I am working at my job, more than usual Avoidance coping: I am finding it difficult to create any structure to my day, more than usual I am finding it difficult concentrate on physically doing anything, more than usual I am taking over the counter medication / tablets, more than usual I am taking prescription medication / tablets, more than usual I have been passive, more than usual I have been drinking alcohol, more than usual I have been smoking, more than usual I have been taking drugs, more than usual I have been eating unhealthy food, more than usual I have been less physically active than usual I have decided the best thing is to stop thinking about it completely
Protection Motivation Theory	**Perceived severity**	I believe this whole thing is exaggerated
	Perceived vulnerability	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being (mental health)
	Perceived self-efficacy	I am confident that this threat will not affect me or my family
	Perceived efficacy of recommended preventative behaviour	N/A

Supplementary Material 2

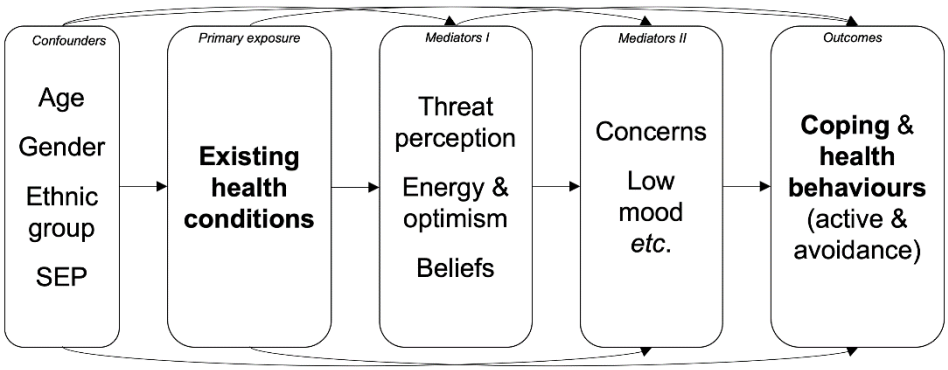

Figure 1. A diagram depicting the roles of the variables involved in our analyses. Note that Figure 1 is not a causal diagram, but a depiction of the role played by each variable in our analysis. There is a possibility of unmeasured confounding (of exposure and outcomes, exposure and mediators, and mediators and outcome) throughout, which should be considered when interpreting the results.

Supplementary Material 3

Table 2. Variable Definitions

Variable	Sum of Responses to Survey Items
Threat Perception	
Primary	4 - "I believe this whole thing is exaggerated" + 4 - "I am confident that this threat will not affect me or my family" + " I believe this is a real threat to mine or my family's health" + "I believe this is a real threat to my or my family's well-being"
Consequences	4 - "I think things are never going to be the same again" + "I believe something positive will come from this threat"
Energy/Optimism	" I feel optimistic for the future beyond this threat" + " I feel energised in response to this threat"
Concern	" I am worried for me or my family now" + "I am worried for my or my family's future" + "I feel worried about my health" + "I am concerned about spending so much time on my own" + "I am concerned about spending so much time with my family"
Low Mood	" I feel down or depressed about this threat" + "I feel numb or unable to feel anything" + "I am finding it difficult to create any structure to my day, more than usual" + "I am finding it difficult concentrate on physically doing anything, more than usual"
Active Coping	" I am keeping busy with practical, everyday living or work tasks, more than usual" + " I am working at my job, more than usual" + " I have been doing active work in my community (that could be work community; locality or family or friendship groups), more than usual" + "I have taken the initiative to reach out to others virtually, more than usual" + "I have taken the initiative to reach out to others physically (e.g. volunteering or caring for neighbours), more than usual" + "I am focusing on finding the positives every day, more than usual" + "I have been physically active, more than usual" + "I have been practicing psychological techniques such as mindfulness or yoga, more than usual" + "I have decided to learn everything I can about this threat" + "I have taken steps to stay healthy and fit, more than usual" + "I have been spending time with family physically, more than usual" + "I have been spending time with family virtually, more than usual"
Avoidance Coping	"I am taking over the counter medication/tablets, more than usual" + "I am taking prescription medication/tablets, more than usual" + "I have been passive, more than usual" + "I have been drinking alcohol, more than usual" + "I have been smoking, more than usual" + "I have been taking drugs, more than usual" + "I have been eating unhealthy food, more than usual" + "I have been less physically active than usual" + "I have decided the best thing is to stop thinking about it completely" + "I have kept to a structured timetable for everyday activities, more than usual"

[1] Responses were converted to integers from 0 to 4 with Strongly disagree = 0 and strongly agree = 4 before definitions were used to sum the responses into scores.

[2] The "belief" scores were each included individually (i.e. not combined together into a score) - and these were Scientists, Politicians, Healthcare Staff, Faith and Cannot Influence.

Supplementary Material 4

More details of the strategy for accounting for missing data

We used 10 burn-in iterations and the univariate imputation model for each of the Likert-scale responses was a multinomial logistic regression including all other item responses and the exposure and confounders as predictors, with no product terms; the score variables (for some of the mediators and both outcomes) were derived from these imputed items. In a sensitivity analysis (not reported), we compared this with multiple imputation (10 imputations) for each of the main regression models, but due to the very low proportion of missing information, the estimates and standard errors were the same to the number of decimal places quoted. For this reason, and since multiple imputation for valid standard error estimation for the mediation analyses is unnecessary due to bootstrapping, all analyses reported are based on a single set of stochastic imputations.

Supplementary Material 5

More details on the method for sequential multiple mediator analysis

We used an estimation-by-simulation approach (with the Monte Carlo sample size equal to the study sample size) to combine appropriately the estimated parameters of each sequential regression model to estimate the effects suggested by VanderWeele and Vansteelandt (2014), which partition the total effect into direct and indirect effects as described in the Main Manuscript. An analytic expression for the standard errors of these mediated effects is intractable, and thus we used the non-parametric bootstrap (with 100 bootstrap samples). As with any mediation analysis method, it relies on very strong assumptions as discussed in detail by VanderWeele and Vansteelandt. In the context of this study, the crucial additional assumptions are that there be no unmeasured common causes of EHC and the coping outcomes, nor of EHC and either set of mediators, nor of either set of mediators and the coping outcomes. In addition, no confounders of the mediators (considered jointly) and the coping outcomes should be affected by EHC. This latter assumption is met for most of the confounders, with the possible exception of employment status, since those with the most serious EHCs may be unable to work because of their condition. This would also be a problem for our main analysis, in which employment is used as one proxy for SEP, and is hence included as a confounder (rather than a mediator) of the EHC->outcome relationship.

Supplementary Material 6

More details of the method for investigating effect modification

We investigated the extent to which the effects of physical and mental EHCs on active and avoidance coping are modified by low mood, concern, primary threat perception, degrees of belief that scientists, politicians, health care workers and personal faith will overcome the threat, and the degree of fatalism. Since all of these are potentially also mediators of the effect of EHC on coping, we presented the extent to which the controlled direct effect (VanderWeele & Vansteelandt, 2014) of EHC on coping, not via the potential modifier/mediator being considered, is different for different levels of the modifier/mediator. These were estimated directly from the multivariable linear regression models described above, with additional product terms between each potential modifier/mediator and the exposure (using the 'margins' command in Stata) with standard errors (and hence 95%CIs) calculated using the delta method.

Supplementary Material 7

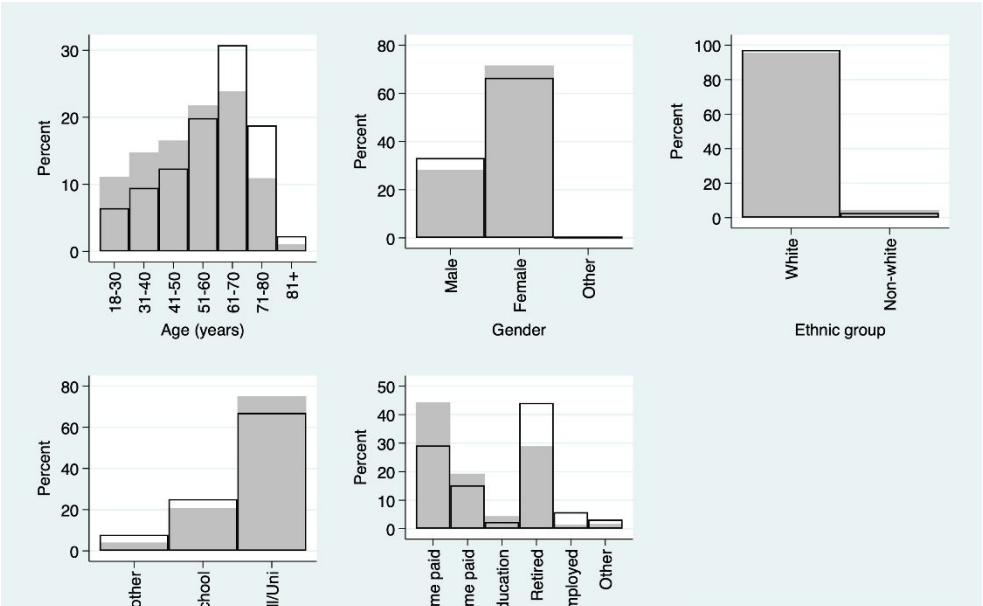

Figure 2. A graphical display of differences in age, gender, ethnicity, education level and employment status between people with and with EHCs.

Supplementary Material 8

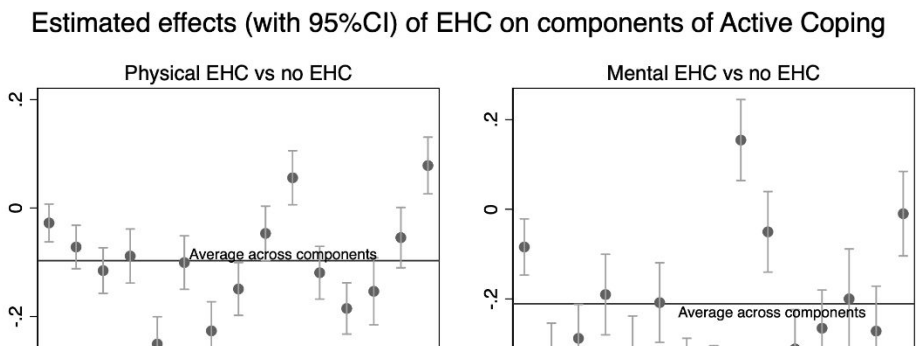

Figure 3. The estimated effects of physical EHC (-1.46) and mental EHC (-3.16) on active coping score split into its effects on each of the component questions making up this score. For a fuller description of each question, see earlier variable descriptions.

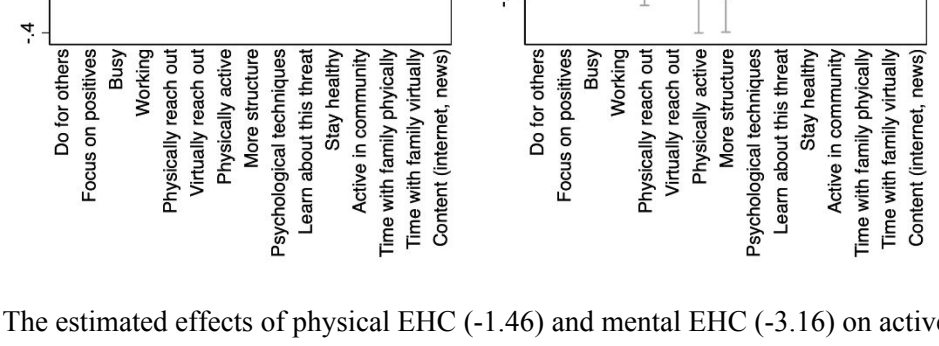

Figure 4. The estimated effects of physical EHCs (1.11) and mental EHCs (3.06) on avoidance coping score split into its effects on each of the component questions making up this score. For a fuller description of each question, see variable descriptions.

Supplementary Material 9

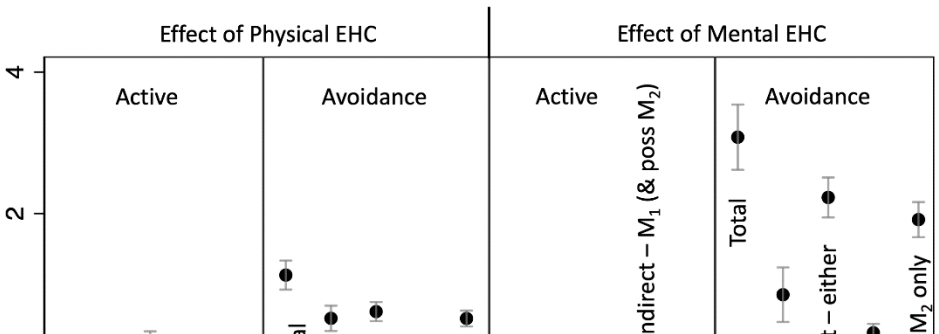

Figure 5. A visual depiction of the sequential multiple mediator effect estimates in Table 4

Supplementary Material 10

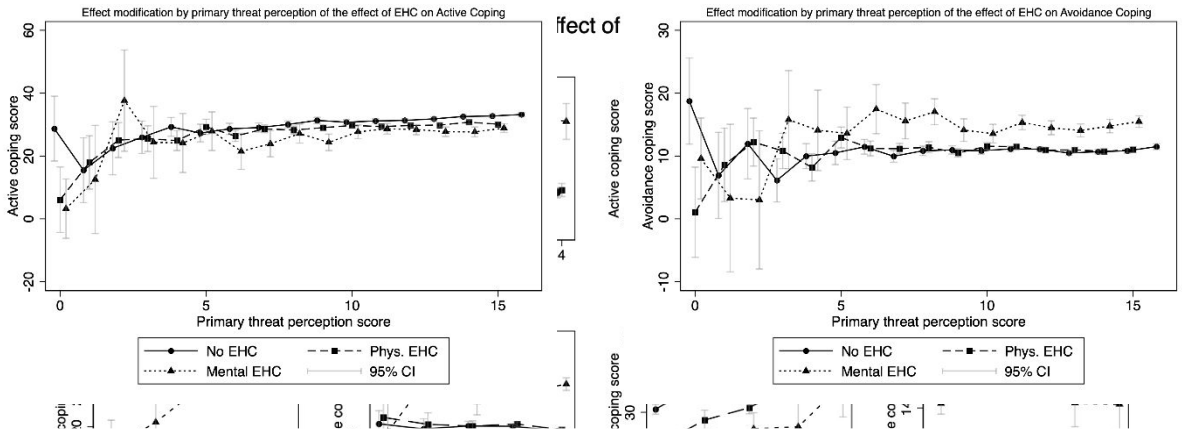

Figure 6. A visual depiction of effect modification by threat perception of SARS-CoV-2 on coping

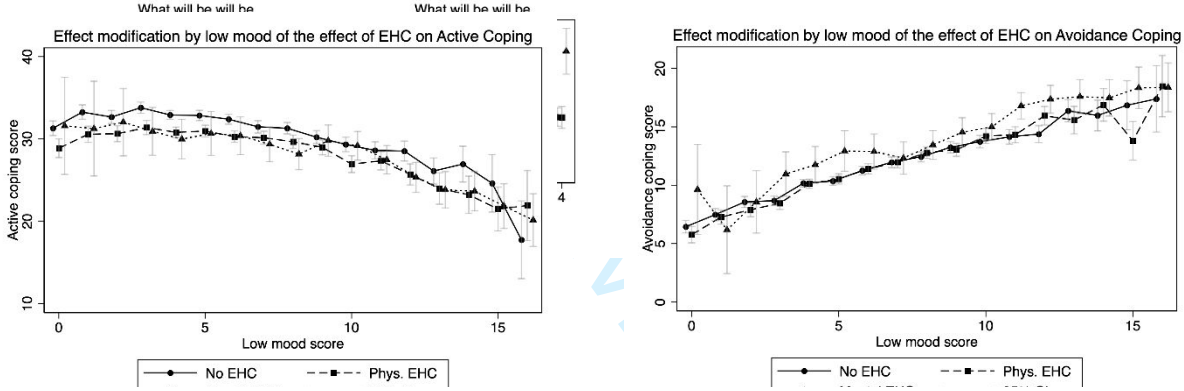

Figure 9. A visual depiction of effect modification by beliefs about SARS-CoV-2 on coping behaviour

F

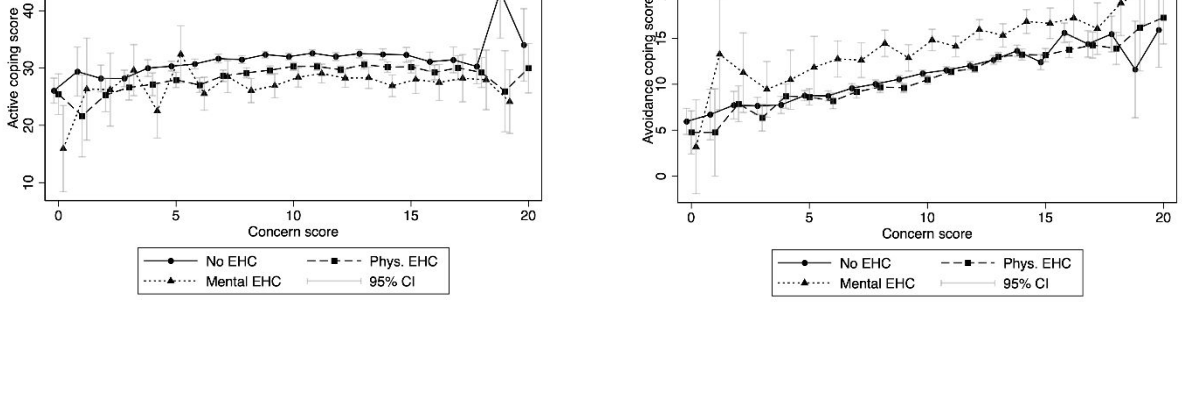

Figure 8. A visual depiction of effect modification by concern related to SARS-CoV-2 on coping

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

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

		(*b*) Report category boundaries when continuous variables were categorized	7- 13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7- 13
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13, 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13 - 15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13 - 15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

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

BMJ Open

Online survey comparing coping responses to SARS-CoV-2 by people with and without existing health conditions in the UK

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Secondary Subject Heading:	Health policy, Infectious diseases, Mental health
Keywords:	COVID-19, MENTAL HEALTH, MEDICAL EDUCATION & TRAINING

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Online survey comparing coping responses to SARS-CoV-2 by people with and without existing health conditions in the UK

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Running head: Comparison of coping responses to SARS-CoV-2

Key words: Existing health conditions, SARS-CoV-2, health beliefs, behaviour, coping

Word count: 2,953
Table count: 5
Figure count: 9

ABSTRACT

Objectives

To investigate the impact of SARS-CoV-2 on self-reported mood, coping and health behaviours of people living with existing health conditions in the UK to understand how to improve coping responses to the threat of SARS-CoV-2.

Design

Quantitative design using a cross-sectional survey.

Setting

Online survey in the UK.

Participants

UK adults (18 years +) were eligible to participate. A total of 9110 people participated. Of these, 4,377 (48%) reported at least one existing health condition, 874 (10%) reported having two or more existing conditions, and 715 (8%) reported having an existing mental health condition.

Primary and secondary outcome measures

Multivariable linear regression and sequential multiple mediation analysis were used to estimate differences in average scores for active and avoidant coping responses scores due to pre-existing health conditions, and to investigate the extent to which these differences are explained by differences in perceptions, beliefs, concerns and mood.

Results

People with pre-existing physical (+1.11 higher; 95% CI 0.88-1.34) and especially mental health conditions (3.06 higher; 95% CI 2.65-3.48) reported poorer health and used more avoidant coping compared to healthy participants. Under some strong untestable assumptions, we estimate that experiencing low mood or concern related to SARS-CoV-2 mostly explained the relationship between existing health conditions and avoidant coping.

Conclusion

Psychological support and interventions including behaviour change is required to mitigate the psychological burden of the SARS-CoV-2 pandemic and increase autonomy in people with and without pre-existing conditions during this highly uncertain time. Psychologists are well-placed to support clinicians and people with existing health conditions to minimise the psychological impact of SARS-CoV-2, in order to alleviate the subsequent strain on healthcare services.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This is the first theory led study in the UK to investigate cognitive, emotional and behavioural responses to the threat of SARS-CoV-2 among people who are vulnerable due to living with physical and mental health conditions.
- The rapid launch of the survey allowed data to be collected in real time but prohibited the validation of survey items.
- The majority of participants identified as being of white ethnic origin limiting the generalizability of the findings to other ethnic groups, who we know to be disproportionately affected by SARS-CoV-2.
- The study was conducted by a multidisciplinary team with backgrounds in health psychology, statistics and nursing and a member of the public.

INTRODUCTION

On 23rd March 2020, the UK government imposed a national movement restriction (lockdown) to control the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This caused major disruption to the economy, public systems (including disruption to health services) and signalled a serious potential threat to people's health and well-being.[1] Responses to SARS-CoV-2 differed between countries and individuals differed in their reactions depending on the perception of this threat to health.

Perception of a health threat drives subsequent emotional and behavioural responses to it (Common Sense Model of Self-Regulation [CSM]).[2] Thus, what people think and feel about SARS-CoV-2 affects how they cope with it. We know that avoidant coping, including for example excessive alcohol intake or unhealthy, so called 'comfort' eating, can adversely affect health outcomes.[3] These health-threatening behaviours perpetuate the risk of serious non-communicable diseases, including cardiovascular and metabolic diseases and some cancers.[4] Smoking[5] and being overweight or obese are associated with increased risk of hospitalization, severe disease progression[6] and death due to SARS-CoV-2.[7] People living with existing health conditions (EHCs) are generally more susceptible to poor health and behavioural outcomes,[8] which could worsen their condition(s) and further reduce their ability to cope with the threat of SARS-CoV-2.[9]

Higher rates of suicidal ideation, stress related to SARS-CoV-2, anxiety and depression were evident among people with a mental EHC in the early stages of lockdown,[10] and the presence of an EHC predicted worse mental health.[11] This suggests that individuals with EHCs, mental illnesses especially,[10] may be particularly vulnerable to poorer psychological outcomes related to SARS-CoV-2 and may require additional psychological support,[12 13] but these studies do not explain the psychological mechanisms underpinning health behaviours. A recent study showed that anxiety related to SARS-CoV-2 reduced general health and peoples' ability to cope with stress during the global pandemic,[14] though most participants (86%) reported no EHCs, limiting the generalizability of the findings.

Few studies have investigated how the threat of SARS-CoV-2 impacts on people with EHCs.[9] Umucu and Lee (2020)[15] found that perceived stress related to SARS-CoV-2 was associated with maladaptive coping in people with chronic conditions and disabilities in the USA. However, their sample was small and coping responses between people with mental and physical EHCs were not compared. Comparing coping responses between groups and identifying the underlying psychological factors is essential for designing appropriate support for people with EHCs to cope with SARS-CoV-2.

We investigated the impact of SARS-CoV-2 on self-reported beliefs, mood and health behaviours of people in the UK living with one or more existing physical or mental EHCs in order to inform future interventions.

METHODS

Design

A cross-sectional online survey including free-text response boxes.

Participants

Adults aged 18 years and over living in the UK.

Materials

An online survey was developed comprising four sections (Supplementary Material 1): (1) participant demographics; (2) personal beliefs; (3) emotions; and (4) behaviour towards the threat of SARS-CoV-2. Survey items in these sections were based on some, but not all, concepts from existing dominant theories and models of responses to health threats, including the CSM,[2] the Transactional Model of Stress and Coping,[16] the Health Belief Model,[17] and Protection Motivation Theory.[18] A combination of complementary theories and models was favoured as each is particularly suited to examining either cognitions, emotions or coping responses [19]. The key theoretical concepts and related survey items are summarised in Supplementary Material 2.

Items were based on a five-point Likert scale ranging from 'completely disagree' to 'completely agree'. A free-text box was included at the end of each section for participants to provide additional comments. To ensure data were captured in real time, the survey was not validated before use.

Procedure

Ethics approval was obtained from School of Healthcare Sciences, Cardiff University (SREC: 637).

The snowball sampling technique was adopted to recruit participants through existing author contacts via email and WhatsApp, as well as the websites and social media platforms (Twitter, Facebook, Instagram) of Cardiff University, HealthWise Wales (a research participant database) and Hywel Dda Health Board.

Survey completers were encouraged to share the survey. Informed consent was obtained prior to participants completing the survey. The survey was open from 8th April to 14th June 2020.

Patient and public involvement

A member of the public was involved in the analysis and interpretation of the free-text responses.

Analysis

We were primarily concerned with the extent to which EHCs affect coping and health behaviours, and the extent to which any effect is mediated through and moderated by different perceptions and emotions (Supplementary Material 3). Age, gender, ethnic group and socio-economic position (proxied by educational qualifications and employment status) were considered as confounders. Variable definitions can be found in Supplementary Material 4. Chi squared tests were conducted to examine the relationship between EHCs and demographic variables.

Missing data

The confounder and exposure data were completely observed. There were small amounts of item non-response in all other variables, ranging from 0.1% to 2%, with a mean non-response proportion of 0.4% per item. However, due to the non-monotone pattern of non-response, 1,494 (16%) of the participants were missing at least one of the relevant items. A single stochastic regression imputation using chained equations [20] was performed (Supplementary Material 5).

Overall effect: What is the effect of EHCs on Coping and Health Behaviours?

We fitted two multivariable linear regression analyses to the two coping outcomes (active and avoidance) with the exposure and confounders included as predictors. The exposure, EHC, was categorised into three groups: (1) no EHC; (2) at least one physical EHC but no mental EHC; and (3) a mental EHC, including those with both physical and mental EHCs. In a secondary analysis, to check if any differences identified in the first analysis were dominated by one or a small number of components, we repeated the above for each component of the active and avoidance coping scores separately (and not adjusting for each other). The estimated mean differences in the coping outcomes between EHC groups, adjusted for age, gender, ethnicity, education and employment, together with their 95% confidence intervals, are reported.

Mediation: To what extent is the effect of EHCs on Coping and Health Behaviours mediated through threat perception and feelings?

A sequential multiple mediator analysis [21] was performed to investigate the extent to which threat perception and emotions mediated the effect of EHCs on coping and health behaviours. The mediators were split into two groups (see Supplementary Material 3) and an estimation-by-simulation approach was used to partition the estimated overall effect of EHCs on the coping outcomes first into (A) an indirect effect via some or all of the mediators and (B) a direct effect not via any of the mediators considered, and second to partition the indirect effect (A) into (A1) the indirect effect through the first set of mediators and (A2) the indirect effect through the second set of mediators, where any effect through both sets in sequence is included in (A1) (see Supplementary Material 6) for the full details, including the strong no unmeasured confounding assumptions on which this partitioning relies).

Effect modification: To what extent is the effect of EHCs on Coping and Health Behaviours modified by threat perception and feelings?

Effect modification was investigated directly from the multivariable linear models, with product terms added (see Supplementary Material 7).

RESULTS

There were 9,110 respondents; 4,377 (48%) reported at least one EHC, of which 874 (10%) reported having two or more EHCs, and 715 (8%) report having an existing mental health condition. Sample characteristics are presented in Table 1.

Table 1: Sample characteristics

	n (%)
Total	9110
Survey	
Cardiff University	3016 (33.1)
Healthwise Wales	6076 (66.7)

Hywel Dda	18 (0.2)
Country	
England	52 (0.8)
Wales	6139 (99)
Scotland	9 (0.1)
Age (Years)	
18 – 30	807 (8.9)
31 – 40	1111 (12.2)
41 – 50	1322 (14.5)
51 – 60	1898 (20.8)
61 – 70	2472 (27.1)
71 – 80	1337 (14.7)
81+	150 (1.6)
Gender	
Male	2791 (30.6)
Female	6298 (69.1)
Other	15 (0.3)
EHCs	
Cardiovascular	791
Respiratory	1103
Diabetes	579
Cancer	235
Dementia	4
Mental illness	715
Pregnancy	64
Other	1931
Ethnicity	
White	8783 (96.4)
Black	34 (0.4)
Asian	101 (1.1)
Mixed/Multiple Ethnic Groups	87 (1)

Other Ethnic group	105 (1.2)
Highest qualification	
Usual high school qualifications in your country at age 16 (e.g. GCSE, O-level)	1260 (13.8)
Usual high school qualifications in your country at age 18 (E.g. AS level, A-Level)	828 (9.1)
A college or university diploma or degree	3945 (43.3)
A higher degree or professional qualification (e.g. a Doctorate or Masters level degree)	2543 (27.9)
None of these qualifications	318 (3.5)
Other	140 (1.5)
Normally occupied	
Full-time	3379
Part-time	1595
Unemployed, seeking work	67
Unemployed, not seeking work	281
Full-time education	340
Part-time education	102
Volunteer	436
Homemaker	256
Retired	3387

Participants without EHCs tended to be younger, female, from an ethnic group other than white, educated to college- or university-level, and in (full- or part-time) employment or education. All of these findings are significant at $p<0.001$ (chi squared test), though some differences were small (Supplementary Material 8).

After adjusting for cofounding variables (age, gender, ethnic group, education and employment) having an EHC is estimated to decrease active coping scores but increase avoidance coping scores. Those with at least one physical EHC (but no mental EHC) had an active coping score on average 1.46 lower (95%CI 1.11-1.80) and an avoidance coping score on average 1.11 higher (95% CI 0.88-1.34) than those without an EHC. The effect of having a mental EHC was greater than having a physical EHC. Those with a mental EHC (including those with both a mental and physical EHC) had an active coping score on average 3.16 lower (95%CI 2.54-3.78) and an avoidance coping score on average 3.06 higher (95% CI 2.65-3.48) than those without an EHC. The observed standard deviations of active and avoidance coping score variables in this sample (7.9 and 5.5, respectively), indicate the absolute magnitude of the significant effects were relatively small (Table 2).

Table 2: Results of linear regression models for active coping (LHS) and avoidance coping (RHS) on the categorical exposure EHC (none/at least one physical EHC but no mental EHC/mental EHC) and confounders

	Active Coping Score				Avoidance Coping Score			
	Estimated coefficient	95% CI		p-value	Estimated coefficient	95% CI		p-value
Existing health condition (EHC) (baseline = none)								
>=1 physical but no mental EHC	-1.46	-1.80	-1.11	0.001	1.11	0.88	1.34	0.001
Mental EHC	-3.16	-3.78	-2.54	0.001	3.06	2.65	3.48	0.001
Age (baseline = 18-30 yrs)								
31 to 40 yrs	0.25	-0.47	0.97	0.50	-0.43	-0.94	0.05	0.08
41 to 50 yrs	1.11	0.41	1.82	0.001	-1.18	-1.66	-0.71	0.001
51 to 60 yrs	1.38	0.69	2.06	0.001	-2.31	-2.76	-1.85	0.001
61 to 70 yrs	1.66	0.90	2.42	0.001	-3.31	-3.82	-2.80	0.001
71 to 80 yrs	1.27	0.39	2.15	0.01	-3.71	-4.30	-3.12	0.001
81+ yrs	0.34	-1.12	1.79	0.65	-3.66	-4.64	-2.69	0.001
prefer not to say	2.27	-1.97	6.52	0.29	-1.15	-3.99	1.70	0.43
Gender (baseline = male)								
Female	1.50	1.14	1.85	0.001	1.22	0.98	1.45	0.001
Other	-1.03	-4.36	2.30	0.55	-0.44	-2.67	1.79	0.70
Ethnic group (baseline = white)								
Non-white	0.44	-0.42	1.31	0.31	0.12	-0.46	0.70	0.69
Highest educational qualification (baseline = none/other)								
School-level	0.39	-0.34	1.12	0.29	-0.49	-0.99	-0.00	0.05
College- or University-level	1.99	1.30	2.67	0.001	-1.44	-1.90	-0.98	0.001

Current employment status (baseline = Full-time paid work)								
Part-time paid work	-0.03	-0.50	0.44	0.91	-0.29	-0.60	0.03	0.07
in education	-0.48	-1.44	0.48	0.33	-0.57	-1.21	0.07	0.08
Retired	-1.92	-2.49	-1.35	0.001	-1.16	-1.54	-0.79	0.001
Unemployed	-6.32	-7.22	-5.41	0.001	-0.36	-0.91	0.24	0.24
Other	-1.47	-2.53	-0.42	0.01	0.14	-0.51	0.84	0.70
Intercept	28.68	27.74	29.61	0.001	13.58	12.95	14.21	0.001

A secondary analysis of each component of active and avoidance coping scores, adjusted for the same confounders, showed that no single component was dominant in driving the results, and the results of some components in each score were in the opposite direction to the majority (Supplementary Material 9).

A sequential multiple mediator analysis was performed to investigate the extent to which threat perception and feelings mediated the effect of EHCs on Coping and Health Behaviours. Supplementary Material 3 displays the mediators of interest.

Table 3 and Supplementary Material 10 show partitioning of active and avoidance coping outcomes into direct and indirect effects, and further into the indirect effects via the two groups of mediators separately; this is done for both the physical and mental EHC exposure comparisons. For the effect of one or more physical EHCs on active coping, almost no effects were mediated. Approximately 54% (95% CI: 43%-65%) of the effect of physical EHCs on avoidance coping was mediated via some or all of the mediators; 46% (95% CI: 36%-56%) via concern and low mood, and 9% (95% CI: 1%-17%) via the first set (including any effects through both sets). For the effect of mental EHC on active coping, an estimated 23% (95% CI: 14%-32%) of the effect was mediated by some or all of the mediators: 11% (95% CI: 3%-19%) via the first set (including any effects through both sets) and 12% (95% CI: 6%-18%) via concern and low mood only. An estimated 72% (95% CI: 63%-82%) of the effect of mental EHC on avoidance coping was mediated via some or all of the mediators; 62% (95% CI: 53%-71%) estimated to be mediated via the second set only and the remaining 10% (95% CI: 6%-14%) via the first set (including any effects through both sets).

Table 3: Results of sequential multiple mediator analyses for active (LHS) and avoidance coping (RHS)

	Active Coping Score				Avoidance Coping Score			
	Estimated effect	95% CI		p-value	Estimated effect	95% CI		p-value
Total effect of Existing health condition (EHC) (baseline = no EHC)								
>=1 physical but no mental EHC	-1.44	-1.81	-1.08	0.001	1.13	0.92	1.33	0.001
Mental EHC	-3.51	-3.87	-2.42	0.001	3.08	2.62	3.54	0.001
Natural direct effect of EHC Not mediated by $\mathbf{M}_1$ nor $\mathbf{M}_2$ (baseline = no EHC)								
At least one physical EHC	-1.61	-1.94	-1.27	0.001	0.52	0.34	0.7	0.001
Mental EHC	-2.43	-3.07	-1.79	0.001	0.85	0.46	1.24	0.001
Natural indirect effect of EHC Mediated by either $\mathbf{M}_1$ or $\mathbf{M}_2$ or both. (baseline = no EHC)								
At least one physical EHC	0.16	-0.01	0.33	0.06	0.61	0.48	0.75	0.001

Mental EHC	-0.72	-1.04	-0.40	0.001	2.23	1.94	2.51	0.001
Natural indirect effect of EHC Mediated by $\mathbf{M}_1$ (and possibly $\mathbf{M}_2$) (baseline = no EHC)								
At least one physical EHC	-0.01	-0.15	0.13	0.88	0.10	0.01	0.19	0.03
Mental EHC	-0.35	-0.60	-0.09	0.01	0.31	0.19	0.44	0.001
Natural indirect effect of EHC Mediated by $\mathbf{M}_2$ only (baseline = no EHC)								
At least one physical EHC	0.17	0.09	0.26	0.001	0.51	0.40	0.63	0.001
Mental EHC	-0.37	-0.57	-0.18	0.001	1.91	1.67	2.16	0.001

Finally, we investigated the extent to which the effects of physical and mental EHCs on active and avoidance coping are modified by low mood, concern, primary threat perception, degrees of belief that scientists, politicians, health care workers and personal faith will overcome the threat, and the degree of fatalism ("what will be will be"). The effect of EHC on coping was remarkably stable across levels of all considered effect modifiers (see Supplementary Material 11).

DISCUSSION

People living with one or more EHCs reported more avoidance than active coping behaviours in response to the threat of SARS-CoV-2 compared to participants with no EHCs. Avoidance coping was more common among people with mental EHCs than physical EHCs. Although based on strong "no unmeasured confounding" assumptions, that demand caution in interpretation, our results suggest that the effects of the mental EHC exposure were mediated to a greater extent than the effects of the physical EHC exposure and that the effects on the avoidance coping outcome were mediated to a greater extent than the effects on the active coping outcome. Most of the mediation occurred via concern and low mood, though the effects of avoidance coping were mediated by primary threat perception, fatalism, personal faith and belief that scientists, politicians and health care workers will overcome the threat. Thus, people with EHCs were more likely to use avoidance coping behaviours due to feeling low or anxious.

In summary, people with EHCs, mental EHCs especially, in our large sample coped less effectively with the threat of SARS-CoV-2 during the imposed pandemic restrictions than people with no EHCs, indicating EHCs further inhibit peoples' ability to cope effectively with the threat and impact of SARS-CoV-2. We did not ask people to be specific which mental EHC they experienced, but it is safe to assume these included anxiety and depressive symptoms, which are the most common mental health conditions.

Individuals living with anxiety and depression symptoms are more likely to use health-threatening behaviours including eating unhealthy food or drinking more alcohol than usual as part of poor coping. Anxiety and depression have further increased as a reaction to the current and on-going threat of SARS-CoV-2 and so the provision of dedicated psychological support incorporating behaviour change is urgently needed to address peoples' coping reactions to the health threat.

What the present study adds

The present study provides insight into the cognitive, emotional and behavioural responses of people with EHCs towards the initial threat of SARS-CoV-2. It builds on the work of Umucu and Lee (2020),[15] demonstrating that avoidance coping was common in a much larger sample of adults with different physical and mental health conditions from across the UK. Furthermore, our study suggests that feeling low and anxious about SARS-CoV-2, partially explains the relationship between living with an EHC and avoidance coping. It highlights the need to improve how clinicians and patients manage mood, coping and address behaviour change in current and future health threats.

Strengths and limitations

To our knowledge, this is the first theory led study in the UK to investigate cognitive, emotional and behavioural responses to the threat of SARS-CoV-2 among people who are vulnerable due to living

with physical and mental EHCs. Whilst the rapid launch of the survey prohibited the validation of survey items, we argue that the capture of this large dataset in real time, strengthens rather than limits this study.

A major strength of this study is its large sample size; however, some limitations are apparent. First, our snowball sampling methods may have introduced within subject correlation and biased the findings towards those with access to social media. Second, the majority of participants were female (69.1%) and there is evidence of sex differences in stress responses and coping strategies[22]. Finally, despite targeted efforts to increase diversity, the majority of participants identified as being of white ethnic origin (96.4%). Other ethnic groups are known to be disproportionately affected by SARS-CoV-2 due the higher prevalence of comorbidities and deprivation in these populations.[23] Together, these issues limit the generalizability of the findings.

Finally, the causal interpretation of our estimates, both of the overall effects of EHC on coping outcomes, and of the extent to which these are mediated by threat perceptions, beliefs, concerns and low mood, all rely on strong untestable assumptions, mainly that there are no unmeasured common causes of any two or more of the sets of variables considered. For example, there could be other elements of socio-economic position, beyond that captured by employment status and educational qualification, which confound the relationship between EHC and coping, and/or between the mediators and the outcomes or exposure. If these unmeasured components of low SEP increase the probability of having an EHC, decrease coping scores and increase low mood scores, for instance, then both the overall effect of EHCs and the extent to which it is mediated by low mood may be exaggerated.

Practical implications

The present study highlights that people with EHCs may require additional support to cope with future lockdowns and restrictions. Information alone is unlikely to initiate more appropriate coping and behaviour change.[24] Health psychologists and behavioural scientists have expertise in evidence-based approaches to behaviour change as well as being well-placed to advise government leaders and public health practitioners on appropriate approaches that help people with EHCs to cope effectively throughout pandemics.

The SARS-CoV-2 pandemic resulted in major changes to the delivery of healthcare services; the majority of routine consultations are now delivered remotely, allowing continuity of care.[25] Increased demand has further increased the strain on the NHS, lengthening waiting times for mental health services. In addition, many people with EHCs have been unable or reluctant to attend medical appointments during the pandemic for fear of contracting SARS-CoV-2. The NHS will continue to be strained after the pandemic as it contends with this backlog.[26] It is vital that clinicians acknowledge the cognitive, emotional and behavioural factors facing people with EHC, who regularly access healthcare services, but greater financial investment must be provided to psychological services to support them. Addressing the psychological burden may not only help people with EHCs, but may reduce the long-term strain on the NHS.

Future research

We showed living with an EHC plus low mood and anxiety increases avoidance coping in response to SARS-CoV-2. Future research should focus on health behaviour change interventions between the different conditions and specific patient groups. Understanding peoples' personal experiences of coping could inform the design and development of both population health and individual behaviour change interventions that are feasible to implement and acceptable to people with EHCs.

We remind clinicians of the need to routinely address well-being and coping with patients during medical consultations. Additional educational and training may be necessary to enable clinicians to provide basic psychological support to people with EHCs throughout and beyond the SARS-CoV-2 pandemic.

Conclusion

People who live with a pre-existing physical or mental health condition are more likely to display avoidant coping behaviours in response to SARS-CoV-2, especially when experiencing low mood or anxiety. Given that these emotions are common among individuals with EHCs, increased funding and provision for dedicated psychological support in healthcare settings is urgently needed.

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COMPETING INTERESTS
None

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ETHICS APPROVAL
Ethics approval was obtained from School of Healthcare Sciences, Cardiff University (REC723).

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author, RH, upon reasonable request.

AUTHORS' CONTRIBUTIONS
RH: Study design, data collection, analysis and interpretation, and manuscript drafting. RP: Data analysis and interpretation and manuscript drafting. RD: Data analysis and interpretation and manuscript drafting. JC: Study conception and design, data interpretation and manuscript drafting. OS: Data analysis and interpretation and manuscript drafting. CB: Study concept and design, data collection, analysis and interpretation, and manuscript drafting. All authors were given the opportunity to read and approve the final version of the manuscript for submission.

REFERENCES

1. Varga TV, Bu F, Dissing AS, et al. Loneliness, worries, anxiety, and precautionary behaviours in response to the COVID-19 pandemic: a longitudinal analysis of 200,000 Western and Northern Europeans. *The Lancet Regional Health – Europe* 2021;pre-print doi: https://doi.org/10.1016/j.lanepe.2020.100020
2. Leventhal H, Nerenz DR, Steele DJ. Illness Representations and Coping with Health Threats. In: Baum A, Taylor SE, Singe JE, eds. Handbook of Psychology and Health (Volume IV): Social Psychological Aspects of Health. London: Routledge 1984.
3. Penley JA, Tomaka J, Wiebe JS. The Association of Coping to Physical and Psychological Health Outcomes: A Meta-Analytic Review. *Journal of behavioral medicine* 2002;25(6):551-603. doi: 10.1023/A:1020641400589
4. Organisation WH. *Non-communicable diseases*, 2018.
5. Zvolensky MJ, Garey L, Rogers AH, et al. Psychological, addictive, and health behavior implications of the COVID-19 pandemic. *Behaviour research and therapy* 2020;134:103715-15. doi: 10.1016/j.brat.2020.103715
6. Chang TH, Chou CC, Chang LY. Effect of obesity and body mass index on coronavirus disease 2019 severity: A systematic review and meta-analysis. *Obesity reviews* 2020;21(11):e13089-n/a. doi: 10.1111/obr.13089
7. Popkin BM, Du S, Green WD, et al. Individuals with obesity and COVID-19: A global perspective on the epidemiology and biological relationships. *Obesity reviews* 2020;21(11):e13128-n/a. doi: 10.1111/obr.13128
8. Anderson N, Ozakinci G. Effectiveness of psychological interventions to improve quality of life in people with long-term conditions: rapid systematic review of randomised controlled trials. *BMC Psychology* 2018;6(1):11-11. doi: 10.1186/s40359-018-0225-4
9. Palmer K, Monaco A, Kivipelto M, et al. The potential long-term impact of the COVID-19 outbreak on patients with non-communicable diseases in Europe: consequences for healthy ageing. *Aging clinical and experimental research* 2020;32(7):1189-94. doi: 10.1007/s40520-020-01601-4
10. Fancourt D, Steptoe A, Bu F. Trajectories of anxiety and depressive symptoms during enforced isolation due to COVID-19 in England: a longitudinal observational study. *The Lancet Psychiatry* 2021;8(2):141-49. doi: 10.1016/S2215-0366(20)30482-X
11. Shevlin M, McBride O, Murphy J, et al. Anxiety, depression, traumatic stress and COVID-19-related anxiety in the UK general population during the COVID-19 pandemic. *BJPsych open* 2020;6(6):e125-e25. doi: 10.1192/bjo.2020.109
12. Pedrosa AL, Bitencourt L, Fróes ACF, et al. Emotional, Behavioral, and Psychological Impact of the COVID-19 Pandemic. *Frontiers in psychology* 2020;11:566212-12. doi: 10.3389/fpsyg.2020.566212
13. O'Connor DB, Aggleton JP, Chakrabarti B, et al. Research priorities for the COVID-19 pandemic and beyond: A call to action for psychological science. *The British journal of psychology* 2020;111(4):603-29. doi: 10.1111/bjop.12468
14. Yıldırım M, Akgül Ö, Geçer E. The Effect of COVID-19 Anxiety on General Health: the Role of COVID-19 Coping. *International journal of mental health and addiction* 2021:1-12. doi: 10.1007/s11469-020-00429-3
15. Umucu E, Lee B. Examining the Impact of COVID-19 on Stress and Coping Strategies in Individuals With Disabilities and Chronic Conditions. *Rehabilitation psychology* 2020;65(3):193-98. doi: 10.1037/rep0000328
16. Lazarus RS. Stress, appraisal, and coping. New York: New York : Springer 1984.
17. Hochbaum G, Rosenstock I, Kegels S. H*ealth belief model*. Washington, DC : U.S.: Public Health Service 1952.
18. Rogers RW. A protection motivation theory of fear appeals and attitude change. *The journal of psychology* 1975;91(1):93.

19. Johnston M, Johnston DW. 8.04 - Assessment and Measurement Issues. In: Bellack AS, Hersen M, eds. Comprehensive Clinical Psychology. Oxford: Pergamon 1998:113-35.
20. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in medicine* 2011;30(4):377-99. doi: 10.1002/sim.4067
21. VanderWeele TJ, Vansteelandt S. Mediation Analysis with Multiple Mediators. *Epidemiol Methods* 2014;2(1):95-115. doi: 10.1515/em-2012-0010
22. Tamres LK, Janicki D, Helgeson VS. Sex differences in coping behavior: A meta-analytic review and an examination of relative coping. *Personality and Social Psychology Review* 2002;6(1):2-30. doi: 10.1207/S15327957PSPR0601_1
23. Mishra V, Seyedzenouzi G, Almohtadi A, et al. Health Inequalities During COVID-19 and Their Effects on Morbidity and Mortality. *Journal of healthcare leadership* 2021;13:19-26. doi: 10.2147/JHL.S270175
24. West R, Michie S, Rubin GJ, et al. Applying principles of behaviour change to reduce SARS-CoV-2 transmission. *Nature human behaviour* 2020;4(5):451-59. doi: 10.1038/s41562-020-0887-9
25. Ahmed S, Sanghvi K, Yeo D. Telemedicine takes centre stage during COVID-19 pandemic. *BMJ Innovations 2020* 2020;6:252-54. doi: http://dx.doi.org/10.1136/bmjinnov-2020-000440
26. Association BM. *The hidden impact of COVID-19 on patient care in the NHS in England*, 2020.

Coping during coronavirus survey

Health, wellbeing and coping with COVID-19

The coronavirus outbreak has challenged everyone. People cope in different ways and it may have changed the way you think about your health and your actions. We would like to find out if and in what ways this may have changed your **thinking**, the way you **feel** or **actions** you have taken in order to manage the Covid-19 threat. This is a unique opportunity to find out ways people are coping and what we learn from that we can use to help others who might not be coping so well.

Please help us by completing this short questionnaire, after a few questions about you, the survey is divided into 3 short parts, with part 1 asking about what you think, part 2 asking about what you feel and part 3 asking about how you are acting in relation to the coronavirus threat. Please feel free to share with as wide a group of people as possible, the more diversity we get the more we will learn.

A big thank you from the members of the School of Healthcare Sciences team at Cardiff University.

Consent to take part

Once you have read the participant information sheet (https://static.onlinesurveys.ac.uk/media/account/88/survey/584508/question/Participant_Information_Sheet__076oqv3.docx) please confirm you are happy to complete this survey by agreeing yes to the below. You may download the participant information sheet for your own records.

I am currently living in the UK * *Required*

- Yes
- No

If outside the UK please indicate which country you are currently in.

I am 18 years of age or over * *Required*

- Yes
- No

I have read the information sheet provided * *Required*

- Yes
- No

I understand that my participation is completely voluntary * *Required*

- Yes
- No

I would like to take part in this survey * *Required*

- Yes

No

About you

Are you? ✱ *Required*

- Male
- Female
- Prefer to self describe
- Rather no say

How do you self-describe your gender?

What is your age? ✱ *Required*

- 18 to 30 years
- 31 to 40 years
- 41 to 50 years
- 51 to 60 years
- 61 to 70 years
- 71 to 80 years
- 81+
- prefer not to say

To which group do you consider you belong? ✱ *Required*

- White/White British
- Black/African/Caribbean/Black British
- Asian/Asian British
- Mixed/Multiple Ethnic Groups
- Other Ethnic Group

Please describe your ethnicity

What is your highest level of qualification? ✱ *Required*

- ○ Usual high school qualifications in your country at age 16 (e.g. GCSE, O-level)
- ○ Usual high school qualifications in your country at age 18 (E.g. AS level, A-Level)
- ○ A college or university diploma or degree
- ○ A higher degree or professional qualification (e.g. a Doctorate or Masters level degree)
- ○ None of these qualifications
- ○ Other
- ○ Rather not say

Please describe

How are you normally occupied? ✱ *Required*

Please select at least 1 answer(s).

- ☐ In full-time paid work, as an employee or self-employed
- ☐ In part-time paid work, as an employee or self-employed
- ☐ Unemployed and seeking work
- ☐ Not employed and not currently seeking work
- ☐ In full-time education or training
- ☐ In part-time education or training
- ☐ I do volunteer / unpaid work
- ☐ I work in the home / manage the family
- ☐ I am Retired
- ☐ Rather not say

Do you have any existing health conditions? ✱ *Required*

- ☐ None
- ☐ Cardio-vascular condition
- ☐ Respiratory condition
- ☐ Diabetes
- ☐ Cancer
- ☐ Dementia
- ☐ Mental Illness

- [ ] Pregnancy
- [ ] Other

Please specify your cardio-vascular condition

Please specify your respiratory condition

Which type of diabetes do you suffer from?

Please describe your cancer type

Please describe what type of mental illness you suffer with

If other please specify

Part 1: What do you THINK?

1.a When considering what you **think** about the coronavirus threat, please tell us how much you agree with the statements below ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 13 answer(s).

	Completely disagree	Disagree	Neither agree nor disagree	Agree	Completely agree
I believe this whole thing is exaggerated	☐	☐	☐	☐	☐
I believe this is a real threat to mine or my family's health	☐	☐	☐	☐	☐
I believe this is a real threat to my or my family's well-being (mental health)	☐	☐	☐	☐	☐
I believe scientists will find a solution to this threat	☐	☐	☐	☐	☐
I believe politicians will get us through this threat	☐	☐	☐	☐	☐
I believe Doctors / healthcare staff will get us through this threat	☐	☐	☐	☐	☐
I believe my faith will get me through this threat	☐	☐	☐	☐	☐
I am confident that this threat will not affect me or my family	☐	☐	☐	☐	☐
I believe this is a short-term threat	☐	☐	☐	☐	☐
I believe this is a long-term threat	☐	☐	☐	☐	☐
I think things are never going to be the same again	☐	☐	☐	☐	☐
I think it's important to focus on what I can do for others during this threat	☐	☐	☐	☐	☐
I have decided the best thing is to stop thinking about it completely	☐	☐	☐	☐	☐

I believe what will be will be and I cannot influence things at all	☐	☐	☐	☐	☐
I believe something positive will come from this threat	☐	☐	☐	☐	☐

1. b If there is anything else you wish to tell us about your **thoughts/beliefs in relation to the threat**, please write below

Part 2: How do you FEEL?

2.a Please mark how much you agree with the statements below about how you **feel** about the coronavirus threat. * *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 11 answer(s).

	Completely disagree	Disagree	Neither agree nor disagree	Agree	Completely agree
I am worried for me or my family now	☐	☐	☐	☐	☐
I am worried for my or my family's future	☐	☐	☐	☐	☐
I feel worried about my health	☐	☐	☐	☐	☐
I feel down or depressed about this threat	☐	☐	☐	☐	☐
I am concerned about spending so much time on my own	☐	☐	☐	☐	☐
I am concerned about spending so much time with my family	☐	☐	☐	☐	☐
I feel angry about this threat	☐	☐	☐	☐	☐
I feel guilty about this threat	☐	☐	☐	☐	☐
I feel optimistic for the future beyond this threat	☐	☐	☐	☐	☐
I feel energised in response to this threat	☐	☐	☐	☐	☐
I feel numb or unable to feel anything	☐	☐	☐	☐	☐
I don't feel anything different to usual	☐	☐	☐	☐	☐
I feel confused about how I feel	☐	☐	☐	☐	☐

2.b Anything else you wish to tell us about how you **feel** in relation to the threat, please write below

Part 3: What are you DOING?

3.a Please rate how much you agree with the statements below about what you are **doing** in relation to the coronavirus threat. ✱ *Required*

Please don't select more than 1 answer(s) per row.

Please select at least 24 answer(s).

	Completely disagree	Disagree	Neither agree nor disagree	Agree	Completely agree
I am focusing on finding the positives every day, more than usual	☐	☐	☐	☐	☐
I am keeping busy with practical, everyday living or work tasks, more than usual	☐	☐	☐	☐	☐
I am working at my job, more than usual	☐	☐	☐	☐	☐
I am finding it difficult to create any structure to my day, more than usual	☐	☐	☐	☐	☐
I am finding it difficult concentrate on physically doing anything, more than usual	☐	☐	☐	☐	☐
I have taken the initiative to reach out to others physically (eg. volunteering or caring for neighbours), more than usual	☐	☐	☐	☐	☐
I have taken the initiative to reach out to others virtually, more than usual	☐	☐	☐	☐	☐
I am taking over the counter medication / tablets, more than usual	☐	☐	☐	☐	☐
I am taking prescription medication / tablets, more than usual	☐	☐	☐	☐	☐
I have been physically active, more than usual	☐	☐	☐	☐	☐
I have kept to a structured timetable for everyday activities, more than usual	☐	☐	☐	☐	☐

I have been practicing psychological techniques such as mindfulness or yoga, more than usual	☐	☐	☐	☐	☐
I have decided to learn everything I can about this threat	☐	☐	☐	☐	☐
I have taken steps to stay healthy and fit, more than usual	☐	☐	☐	☐	☐
I have been passive, more than usual	☐	☐	☐	☐	☐
I have been doing active work in my community (that could be work community; locality or family or friendship groups), more than usual	☐	☐	☐	☐	☐
I have been having difficulties sleeping, more than usual	☐	☐	☐	☐	☐
I have been drinking alcohol, more than usual	☐	☐	☐	☐	☐
I have been smoking, more than usual	☐	☐	☐	☐	☐
I have been taking drugs, more than usual	☐	☐	☐	☐	☐
I have been eating unhealthy food, more than usual	☐	☐	☐	☐	☐
I have been less physically active than usual	☐	☐	☐	☐	☐
I have been spending time with family physically, more than usual	☐	☐	☐	☐	☐
I have been spending time with family virtually, more than usual	☐	☐	☐	☐	☐
I have been spending time on the internet or listening to the news/ reading newspapers than usual, more than usual	☐	☐	☐	☐	☐

I have been spending time on social media, more than usual	☐	☐	☐	☐	☐

3.b Anything else you wish to tell us about your **behaviour/actions in relation to the threat**, please write below

Thank you

Thank you for your time, as you did not consent to take part in this survey there will be no further questions.

Final page

Thank you for sharing your ways of coping with us, we appreciate the time taken to complete this questionnaire.

For official information on COVID19 in the UK, please visit https://www.nhs.uk/conditions/coronavirus-covid-19/

Prof. Chris Bundy for the Covid-19 Coping study team

Supplementary Material

Supplementary Material 2

Table 1. *Covid-19 coping survey items mapped to underlying theoretical models and constructs*

Model / Theory	Theoretical Concept	Survey Item
Common Sense Model	**Identity (perception of threat)**	I believe this is a real threat to mine or my families health I believe this is a real threat to my or my family's well-being I am confident that this threat will not affect me or my family
	Controllability (locus of control)	External Locus of Control: I believe scientists will find a solution to this I believe politicians will get us through this threat I believe Doctors / healthcare staff will get us through this threat I believe what will be will be and I cannot influence things at all I believe my faith will get me through this threat Internal Locus of Control: I think it's important to focus on what I can do for others during this threat
	Consequences	I believe something positive will come from this threat I think things are never going to be the same again Emotional Consequences: I am worried for me or my family now I feel confused about how I feel I am worried for my or my family's future I feel down or depressed about this threat I am concerned about spending so much time on my own I am concerned about spending so much time with my family I feel angry about this threat I feel guilty about this threat I feel optimistic for the future beyond this threat I feel energised in response to this threat

		I don't feel anything different to usual I feel numb or unable to feel anything I feel worried about my health
	Timeline	I believe this is a short term threat I believe this is a long-term threat
	Cause	N/A
Health Belief Model	**Perceived susceptibility**	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being I am confident that this threat will not affect me or my family
	Perceived severity	I believe this whole thing is exaggerated
	Perceived benefits	I believe something positive will come from this threat
	Perceived barriers	N/A
Transactional Model of Stress and Coping	**Primary appraisal (significance)**	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being (mental health) I am confident that this threat will not affect me or my family I believe this whole thing is exaggerated I believe this is a short-term threat I believe this is a long-term threat I believe something positive will come from this threat
	Secondary appraisal (personal resources/ options)	I believe my faith will get me through this threat I think it's important to focus on what I can do for others during this threat I believe what will be will be and I cannot influence things at all
	Coping responses	Active coping: I am focusing on finding the positives every day, more than usual I have taken the initiative to reach out to others physically (e.g. volunteering or caring for neighbours), more than usual

		I have taken the initiative to reach out to others virtually, more than usual I have been physically active, more than usual I have kept to a structured timetable for everyday activities, more than usual I have been practicing psychological techniques such as mindfulness or yoga, more than usual I have decided to learn everything I can about this threat I have taken steps to stay healthy and fit, more than usual I have been doing active work in my community (that could be work community; locality or family or friendship groups), more than usual I have been spending time with family physically, more than usual I am keeping busy with practical, everyday living or work tasks, more than usual I am working at my job, more than usual Avoidance coping: I am finding it difficult to create any structure to my day, more than usual I am finding it difficult concentrate on physically doing anything, more than usual I am taking over the counter medication / tablets, more than usual I am taking prescription medication / tablets, more than usual I have been passive, more than usual I have been drinking alcohol, more than usual I have been smoking, more than usual I have been taking drugs, more than usual I have been eating unhealthy food, more than usual I have been less physically active than usual I have decided the best thing is to stop thinking about it completely
Protection Motivation Theory	**Perceived severity**	I believe this whole thing is exaggerated
	Perceived vulnerability	I believe this is a real threat to mine or my family's health I believe this is a real threat to my or my family's well-being (mental health)
	Perceived self-efficacy	I am confident that this threat will not affect me or my family
	Perceived efficacy of recommended preventative behaviour	N/A

Supplementary Material 3

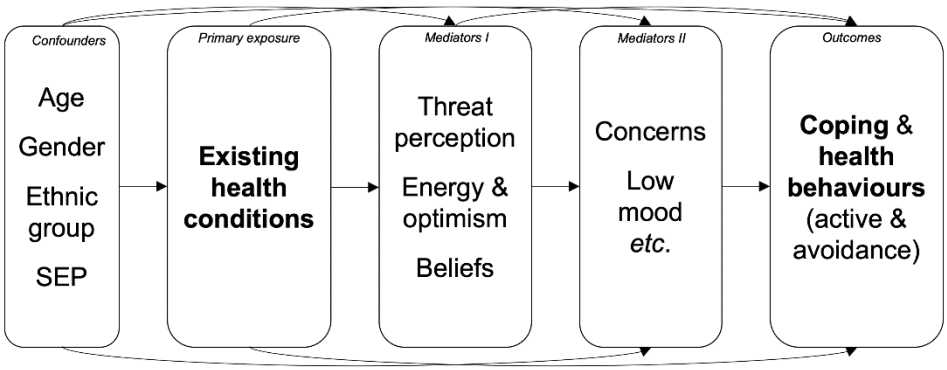

Figure 1. A diagram depicting the roles of the variables involved in our analyses. Note that Figure 1 is not a causal diagram, but a depiction of the role played by each variable in our analysis. There is a possibility of unmeasured confounding (of exposure and outcomes, exposure and mediators, and mediators and outcome) throughout, which should be considered when interpreting the results.

Supplementary Material 4

Table 2. Variable Definitions

Variable	Sum of Responses to Survey Items
Threat Perception	
Primary	4 - "I believe this whole thing is exaggerated" + 4 - "I am confident that this threat will not affect me or my family" + " I believe this is a real threat to mine or my family's health" + "I believe this is a real threat to my or my family's well-being"
Consequences	4 - "I think things are never going to be the same again" + "I believe something positive will come from this threat"
Energy/Optimism	" I feel optimistic for the future beyond this threat" + " I feel energised in response to this threat"
Concern	" I am worried for me or my family now" + "I am worried for my or my family's future" + "I feel worried about my health" + "I am concerned about spending so much time on my own" + "I am concerned about spending so much time with my family"
Low Mood	" I feel down or depressed about this threat" + "I feel numb or unable to feel anything" + "I am finding it difficult to create any structure to my day, more than usual" + "I am finding it difficult concentrate on physically doing anything, more than usual"
Active Coping	" I am keeping busy with practical, everyday living or work tasks, more than usual" + " I am working at my job, more than usual" + " I have been doing active work in my community (that could be work community; locality or family or friendship groups), more than usual" + "I have taken the initiative to reach out to others virtually, more than usual" + "I have taken the initiative to reach out to others physically (e.g. volunteering or caring for neighbours), more than usual" + "I am focusing on finding the positives every day, more than usual" + "I have been physically active, more than usual" + "I have been practicing psychological techniques such as mindfulness or yoga, more than usual" + "I have decided to learn everything I can about this threat" + "I have taken steps to stay healthy and fit, more than usual" + "I have been spending time with family physically, more than usual" + "I have been spending time with family virtually, more than usual"
Avoidance Coping	"I am taking over the counter medication/tablets, more than usual" + "I am taking prescription medication/tablets, more than usual" + "I have been passive, more than usual" + "I have been drinking alcohol, more than usual" + "I have been smoking, more than usual" + "I have been taking drugs, more than usual" + "I have been eating unhealthy food, more than usual" + "I have been less physically active than usual" + "I have decided the best thing is to stop thinking about it completely" + "I have kept to a structured timetable for everyday activities, more than usual"

[1] Responses were converted to integers from 0 to 4 with Strongly disagree = 0 and strongly agree = 4 before definitions were used to sum the responses into scores.

[2] The "belief" scores were each included individually (i.e. not combined together into a score) - and these were Scientists, Politicians, Healthcare Staff, Faith and Cannot Influence.

Supplementary Material 5

More details of the strategy for accounting for missing data

We used 10 burn-in iterations and the univariate imputation model for each of the Likert-scale responses was a multinomial logistic regression including all other item responses and the exposure and confounders as predictors, with no product terms; the score variables (for some of the mediators and both outcomes) were derived from these imputed items. In a sensitivity analysis (not reported), we compared this with multiple imputation (10 imputations) for each of the main regression models, but due to the very low proportion of missing information, the estimates and standard errors were the same to the number of decimal places quoted. For this reason, and since multiple imputation for valid standard error estimation for the mediation analyses is unnecessary due to bootstrapping, all analyses reported are based on a single set of stochastic imputations.

Supplementary Material 6

More details on the method for sequential multiple mediator analysis

We used an estimation-by-simulation approach (with the Monte Carlo sample size equal to the study sample size) to combine appropriately the estimated parameters of each sequential regression model to estimate the effects suggested by VanderWeele and Vansteelandt (2014), which partition the total effect into direct and indirect effects as described in the Main Manuscript. An analytic expression for the standard errors of these mediated effects is intractable, and thus we used the non-parametric bootstrap (with 100 bootstrap samples). As with any mediation analysis method, it relies on very strong assumptions as discussed in detail by VanderWeele and Vansteelandt. In the context of this study, the crucial additional assumptions are that there be no unmeasured common causes of EHC and the coping outcomes, nor of EHC and either set of mediators, nor of either set of mediators and the coping outcomes. In addition, no confounders of the mediators (considered jointly) and the coping outcomes should be affected by EHC. This latter assumption is met for most of the confounders, with the possible exception of employment status, since those with the most serious EHCs may be unable to work because of their condition. This would also be a problem for our main analysis, in which employment is used as one proxy for SEP, and is hence included as a confounder (rather than a mediator) of the EHC->outcome relationship.

Supplementary Material 7

More details of the method for investigating effect modification

We investigated the extent to which the effects of physical and mental EHCs on active and avoidance coping are modified by low mood, concern, primary threat perception, degrees of belief that scientists, politicians, health care workers and personal faith will overcome the threat, and the degree of fatalism. Since all of these are potentially also mediators of the effect of EHC on coping, we presented the extent to which the controlled direct effect (VanderWeele & Vansteelandt, 2014) of EHC on coping, not via the potential modifier/mediator being considered, is different for different levels of the modifier/mediator. These were estimated directly from the multivariable linear regression models described above, with additional product terms between each potential modifier/mediator and the exposure (using the 'margins' command in Stata) with standard errors (and hence 95%CIs) calculated using the delta method.

Supplementary Material 8

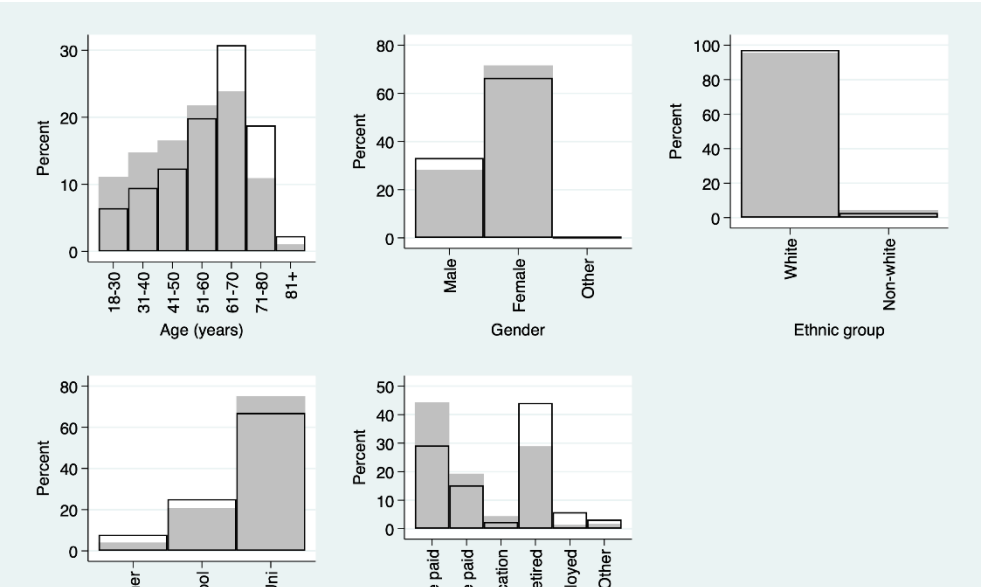

Figure 2. A graphical display of differences in age, gender, ethnicity, education level and employment status between people with and with EHCs.

Supplementary Material 9

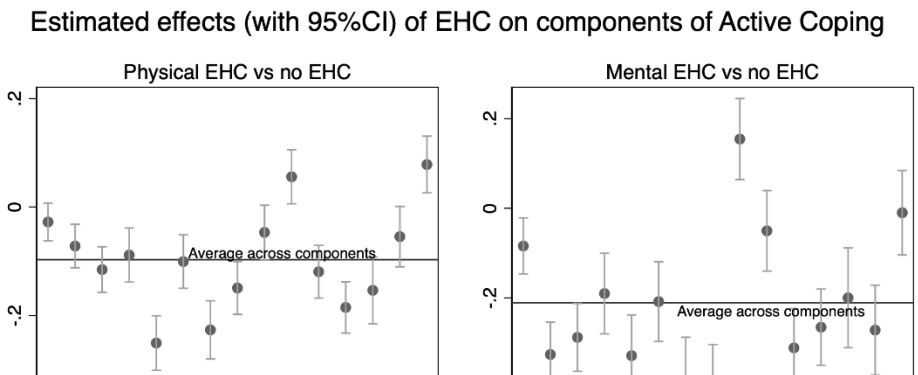

Figure 3. The estimated effects of physical EHC (-1.46) and mental EHC (-3.16) on active coping score split into its effects on each of the component questions making up this score. For a fuller description of each question, see earlier variable descriptions.

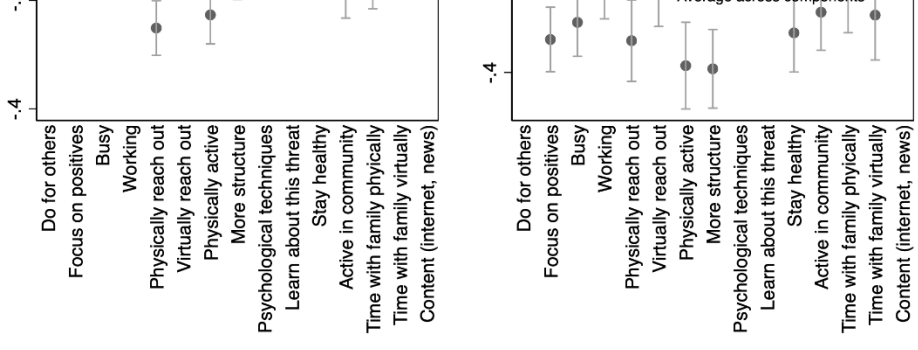

Figure 4. The estimated effects of physical EHCs (1.11) and mental EHCs (3.06) on avoidance coping score split into its effects on each of the component questions making up this score. For a fuller description of each question, see variable descriptions.

Supplementary Material 10

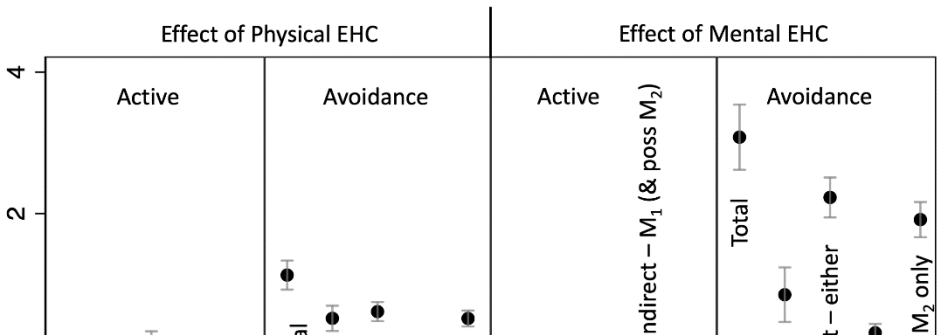

Figure 5. A visual depiction of the sequential multiple mediator effect estimates in Table 4

Supplementary Material 11

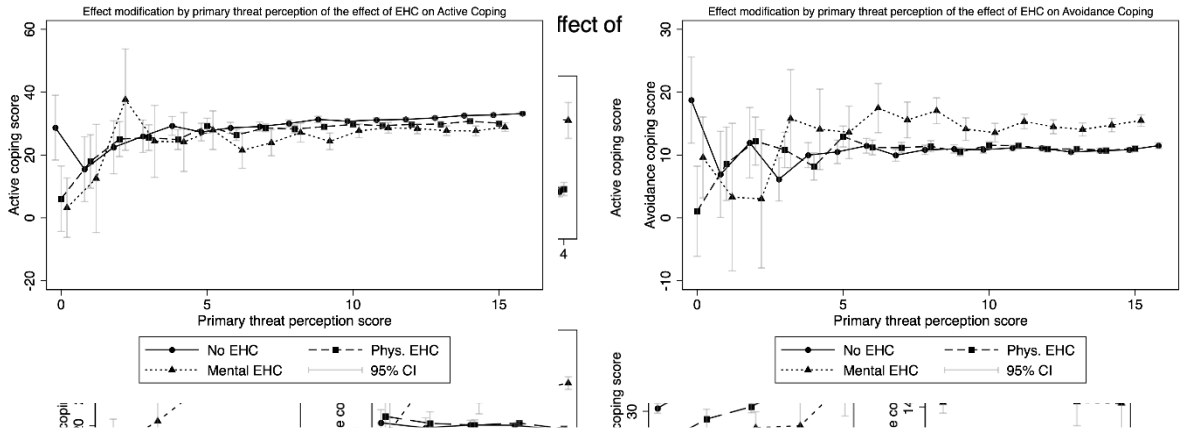

Figure 6. A visual depiction of effect modification by threat perception of SARS-CoV-2 on coping

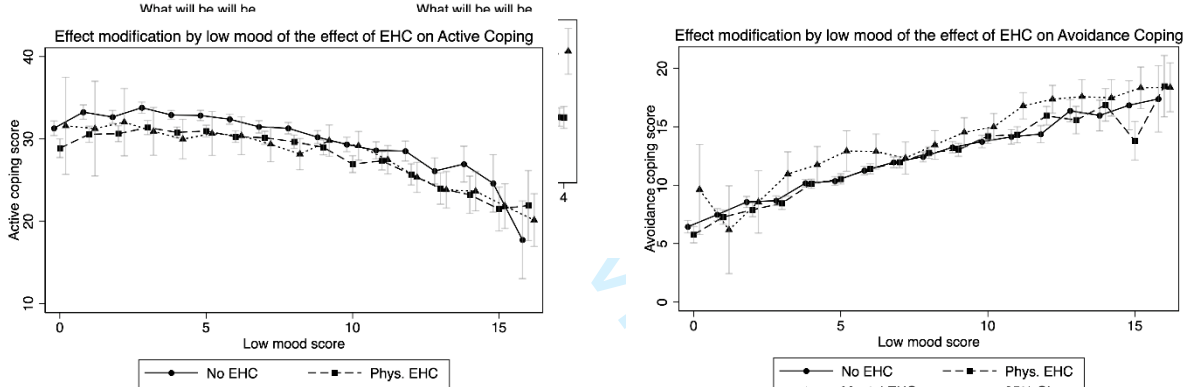

Figure 9. A visual depiction of effect modification by beliefs about SARS-CoV-2 on coping behaviour

F

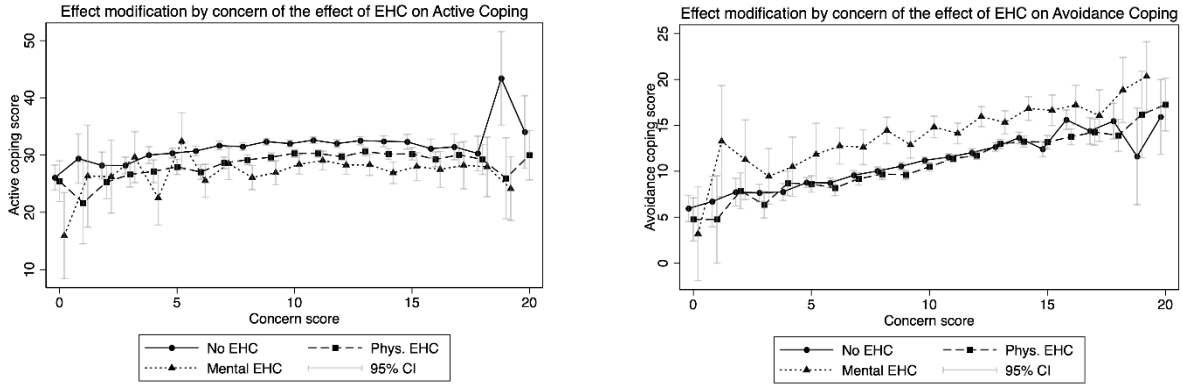

Figure 8. A visual depiction of effect modification by concern related to SARS-CoV-2 on coping

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

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

		(*b*) Report category boundaries when continuous variables were categorized	7- 13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7- 13
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13, 14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13 - 15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13 - 15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

*Give information separately for exposed and unexposed groups.

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