# The association of physical multimorbidity with suicidal ideation and suicide attempts in England

# The association of physical multimorbidity with suicidal ideation and suicide attempts in England: A mediation analysis of influential factors

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**Background:** Suicide is one of the most important causes of deaths in the United Kingdom, and the numbers are currently increasing.

**Aim**: There are numerous identified determinants of suicidality, and physical multimorbidity is potentially important but is currently understudied. Thus, this study aims to investigate the association of physical multimorbidity with suicidality.

**Methods:** Cross-sectional data from the Adult Psychiatric Morbidity Survey 2007, which was conducted in England between October 2006 to December 2007 by the National Center for Social Research and Leicester University were analyzed. Respondents were asked about 20 physical health conditions, and suicidal ideation and suicide attempts were assessed.

**Results:** Out of 7403 individuals aged 16 years or over, the prevalence of physical multimorbidity, suicidal ideation, and suicide attempts were 35.1%, 4.3%, and 0.7%, respectively. After adjustment for potential confounders, compared to no physical conditions, 1, 2, 3, and ≥4 conditions were associated with significant 1.79 (95%CI=1.25-2.57), 2.39 (95%CI=1.63-3.51), 2.88 (95%CI=1.83-4.55), and 6.29 (95%CI=4.12-9.61) times higher odds for suicidal ideation. Mediation analysis showed that cognitive problems (mediated percentage 39.2%) and disability (37.5%) explained the largest proportion between multimorbidity and suicidal ideation. Pain (38.0%) and cognitive problems (30.7%) explained the largest proportion between multimorbidity and suicide attempts.

**Conclusion:** In this large sample of UK adults, physical multimorbidity was associated with significantly higher odds for suicidal ideation and suicide attempts. Moreover, several potential mediators were identified, and these may serve as future targets for interventions that aim to prevent suicidality among people with physical multimorbidity.

## INTRODUCTION

Considering the high and increasing prevalence of suicides in the UK, it is of utmost importance to identify risk factors of suicidal ideation and suicide attempts to aid in the development of targeted interventions. While there is a multitude of identified determinants of suicidal behaviors, one potentially important but understudied risk factor is that of physical multimorbidity.

In the UK, multimorbidity is highly prevalent with data estimating that it affects one in four adults (Stafford et al., 2017). Physical multimorbidity (i.e., ≥2 physical conditions) may increase the risk for suicidal ideation and suicide attempts via, for example, social isolation, disability, perceived burdensomeness, and financial difficulties (Xiong et al., 2020). In terms of the association between physical multimorbidity and suicide attempts, there are much fewer studies. Furthermore, there are currently no studies on physical multimorbidity and suicidal thoughts and behavior from the UK, while the mediators of this association are largely unknown. It is important to identify such mediators as they can act as targets for suicide prevention interventions.

Thus, the present study aimed to investigate associations of physical multimorbidity with suicidal ideation and suicide attempt in a large sample of English adults. A further aim was to investigate to what extent a broad range of psychological, physical, and environmental factors mediate the physical multimorbidity-suicidal ideation/suicide attempt relationships.

## METHODS

Cross-sectional data from the Adult Psychiatric Morbidity Survey (APMS) 2007 (NHS, 2021) were analyzed. The survey was conducted in England between October 2006 and December 2007. To obtain a nationally representative sample of the adult population aged ≥16 years old residing in private households, multistage stratified probability sampling was used. The small user Postcode Address File (PAF) served as the sampling frame with postcode sectors serving as the primary sampling units (PSUs). Sectors were stratified by both region and socioeconomic status. One person was invited to participate from each household that was randomly selected. Information was obtained through computer-assisted personal interviews (CAPI) and computer-assisted self-interviews (CASI). The survey response rate was 57%. To correct for the probability of selection and survey non-response, sampling weights were created to obtain a representative sample of the intended target population. The Royal Free Hospital and Medical School Research Ethics Committee provided ethical approval for the study with all participants providing written informed consent.

***Physical conditions and physical multimorbidity***

Respondents were asked about 20 physical health conditions (cancer, diabetes, epilepsy, migraine, cataracts/eyesight problems, ear/hearing problems, stroke, heart attack/angina, high blood pressure, bronchitis/emphysema, asthma, allergies, stomach ulcer, or other digestive problems, liver problems, bowel/colon problems, bladder problems/incontinence, arthritis, bone/back/joint/muscle problems, infectious disease, and skin problems). To be counted, conditions had to have been diagnosed by a doctor or other health professional and have been present in the previous 12 months. The number of physical conditions was summed and categorized as 0, 1, 2, 3, 4, and ≥5. Multimorbidity was defined as two or more physical conditions (NICE, 2021).

***Suicidal ideation and suicide attempts***

Suicidal ideation was assessed by the question "Have you ever thought of taking your life, even if you would not really do it?" and suicide attempt by the question "Have you ever made an attempt to take your life, by taking an overdose of tablets or in some other way?" For those who answered 'yes', a follow-up question was asked about whether this had occurred in the previous 12 months. Answering 'yes' to the first questions and the follow-up question was considered past 12-month suicidal ideation and suicide attempts, respectively.

***Mediators***

The mediators (i.e., depression, anxiety, insomnia, pain, cognitive problems, perceived stress, loneliness, disability, social support) were selected based on previous literature (Hajek et al., 2020; HHS.gov, 2021; Pu et al., 2017; Sindi et al., 2020; St John et al., 2014; Stravynski and Boyer, 2001; Wei et al., 2020). The interviewers administered the Clinical Interview Schedule Revised (CIS-R). This can be administered by lay interviewers and was used to generate ICD-10 diagnoses of depressive episode and anxiety disorder (generalized anxiety disorder, panic disorder, phobia, obsessive-compulsive disorder) in the prior week (Lewis et al., 1992). The reliability and validity of the CIS-R have been reported in previous publications (Jordanova et al., 2004; Lewis et al., 1992). Insomnia was defined as fulfilling all the following three criteria: (i) problems trying to get to sleep or getting back to sleep (if had woken up) in the past month; and in the past seven days, (ii) had problems with sleep on at least four nights in addition to (iii) taking at least one hour trying to get to sleep on the night with least sleep (Freeman et al., 2010). The question on pain was "During the past four weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?". The answer options were 'not at all', 'a little bit', 'moderately', 'quite a bit', and 'extremely'. Cognitive function was assessed by two questions with 'yes'

and ‘no’ answer options: “In the past month, have you had any problems in concentrating on what you were doing?” (concentration); and “Have you noticed any problems with forgetting things in the past month?” (memory). Two separate dichotomous variables were created for concentration and memory based on these answer options. Cognitive problems were defined as answering ‘yes’ to at least one of these two questions. For perceived stress, participants were asked whether their tasks at work and at home were very stressful over the past two weeks. Answer options were ‘most of the time’, ‘usually’, ‘occasionally’ and ‘not at all’. Disability was defined as having one or more difficulties with seven types of activities of daily living (ADL): personal care, medical care, preparing meals, mobility, shopping, housework, practical tasks such as decorating, dealing with paperwork and managing money (Brewin and Wing, 1989). Respondents were asked to assess to what extent they had felt ‘lonely and isolated from other people’ in the previous two weeks. Answer options were ‘very much’, ‘sometimes’, ‘not often’, and ‘not at all’. The level of social support was assessed by seven questions on whether: family and friends did things to make them happy, made them feel loved, could be relied on no matter what, would see that they were taken care of no matter what, accepted them just the way they are, made them feel an important part of their lives, and gave them support and encouragement. The answer options to these questions consisted of a three-point scale: ‘not true (coded=0)’, ‘partly true (coded=1)’, or ‘certainly true (coded=2)’. Following a scoring method used in a previous publication (Wickham et al., 2014), the answers to these items were summed to create a scale score that ranged from 0 to 14 with higher scores indicating greater social support (Cronbach’s $\alpha = 0.88$).

***Control variables***

The selection of control variables was based on past literature (Huh et al., 2019) and included age, sex, equivalized income tertiles (high ≥£29826, middle £14,057-<£29826, low

<£14,057), education [qualification (degree, non-degree, A-level, GCSE, other): yes or no)], ethnicity (white British or other), smoking (never, past, current), and alcohol dependence. The Alcohol Use Disorders Identification Test (AUDIT) was used to assess alcohol consumption (Saunders et al., 1993). Those with an AUDIT score of 10 and above were assessed for alcohol dependence with the Severity of Alcohol Dependence Questionnaire (SADQ-C) (Stockwell et al., 1994), with scores of 4 and above (out of 60) on this measure being used to determine past 6-month presence of alcohol dependence.

***Statistical analysis***

The statistical analysis was done with Stata 14.2 (Stata Corp LP, College station, Texas). The difference in sample characteristics was tested by Chi-square tests and Student's *t*-tests for categorical and continuous variables, respectively. Multivariable logistic regression analysis was done to assess the association between number of physical conditions (exposure) and suicidal ideation or suicide attempts (outcomes). Test of trend was conducted by including the number of physical conditions in the model as a continuous variable rather than a categorical variable.

Next, in order to gain an understanding of the extent to which various factors may explain the relationship between physical multimorbidity (i.e., ≥2 physical conditions) and suicidal ideation or suicide attempts, we conducted a mediation analysis. We used the *khb* (Karlson Holm Breen) command in Stata (Breen et al., 2013) for the mediation analysis. This method can be applied in logistic regression models and decomposes the total effect (i.e., unadjusted for the mediator) of a variable into direct and indirect effects. Using this method, the percentage of the main association explained by the mediator can also be calculated (mediated percentage). Each potential mediator was included in the model individually.

All regression analyses including the mediation analysis were adjusted for age, sex, income, education, ethnicity, smoking, and alcohol consumption. As approximately one-fifth of the participants did not provide information on income, a missing category was included in the models only for this variable to avoid the exclusion of a large number of participants from the analysis. The sample weighting and the complex study design were taken into account in all analyses. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $P<0.05$.

**RESULTS**

The final sample consisted of 7403 individuals aged ≥16 years [mean (SD) age 46.3 (18.6) years; 48.6% males]. The prevalence of physical multimorbidity (i.e., ≥2 physical conditions), suicidal ideation, and suicide attempts were 35.1%, 4.3%, and 0.7%, respectively. The most common individual physical conditions were bone, back, joint/muscle problems (21.9%) and high blood pressure (16.9%), while the most common pairs of physical conditions were bone, back, joint/muscle problems co-occurring with arthritis (5.6%) or high blood pressure (5.1%) (Appendix **Figure S1**). The sample characteristics are provided in **Table 1**. Physical multimorbidity and suicidal ideation were both associated with higher prevalence of female sex, lower levels of wealth, past or current smoking, depression, anxiety, insomnia, pain, cognitive problems, disability, and higher levels of perceived stress, and loneliness. The prevalence of suicidal ideation and suicide attempts were significantly higher in people with physical multimorbidity, asthma, bladder problems/incontinence, bowel/colon problems, bronchitis/emphysema, epilepsy, and migraine or frequent headaches (**Table 2**). People with arthritis, bone, back, joint or muscle problems, liver problems, skin problems, and stomach ulcers/other digestive problems had a significantly higher prevalence of suicidal ideation but not suicide attempts. The prevalence of suicidal ideation and suicide attempts increased

linearly with an increasing number of physical conditions (**Figure 1**). For example, the prevalence of suicidal ideation was 3.0% among people without physical conditions but this increased to 9.2% among those with ≥4 physical conditions. After adjustment for potential confounders, compared to no physical conditions, 1, 2, 3, and ≥4 conditions were associated with significant 1.79 (95%CI=1.25-2.57), 2.39 (95%CI=1.63-3.51), 2.88 (95%CI=1.83-4.55), and 6.29 (95%CI=4.12-9.61) times higher odds for suicidal ideation (**Table 3**). Three (OR=5.64; 95%CI=1.50-21.19) and ≥4 (OR=13.25; 95%CI=4.58-38.37) physical conditions were associated with significantly increased odds for suicide attempts. The test for trend showed that there is a significant dose-dependent association for both suicidal ideation and suicide attempts. Mediation analysis showed that cognitive problems (mediated percentage 39.2%) mediated the largest proportion of the association between physical multimorbidity and suicidal ideation, followed by disability (37.5%), pain (35.6%), loneliness (30.5%), anxiety (25.5%), insomnia (18.6%), perceived stress (11.7%), and depression (11.5%) (**Table 4**). For suicide attempts, the significant mediators were pain (38.0%), cognitive problems (30.7%), disability (26.3%), loneliness (22.4%), anxiety (17.2%), and depression (6.9%).

## DISCUSSION

Findings from the present study support and add to previous literature. They support previous literature (Xiong et al., 2020) by further confirming that physical multimorbidity is associated with higher odds for suicidal ideation and suicide attempt among adults in England, and add to this literature by identifying potential key mediating variables.

There are several plausible pathways that likely explain the association between physical multimorbidity and suicidal ideation/suicide attempt. First, several physical conditions were individually associated with suicidal ideation and suicide attempt in our study. For example,

epilepsy may increase risk for suicidal behavior as limbic epileptogenic areas in temporal lobe epilepsy, such as the amygdala, are involved in social behaviors, including impulse control, anxiety, and emotional memory. Moreover, altered serotonergic neurotransmission has been described in epilepsy, as well as impulsive and suicidal behavior (de Oliveira et al., 2011). In the case of migraine, literature has shown that the levels of cortisol and functioning of the hypothalamic-pituitary-adrenocortical (HPA) axis are affected by stressful events such as headaches. Specifically, HPA activity has been found to be correlated with low grade cognitive stress in those who experience migraines, and this may subsequently lead to suicidal behaviors (Berhane et al., 2018). Other individual physical conditions identified as being associated with suicidal ideation or suicide attempts may also increase suicidal thoughts and behaviors through suffering caused by the symptoms, hopelessness, and perceived burden, etc.

Interestingly, in our study, cognitive impairment explained the largest proportion of the association between physical multimorbidity and suicidal ideation (% mediated 39.2%) or suicide attempts (30.7%). Multiple individual physical conditions identified in this study as being associated with suicidal thoughts and/or behaviors have also been found to be associated with cognitive impairment [e.g., migraines (de Araújo et al., 2012), asthma (Caldera-Alvarado et al., 2013), arthritis (Wallin et al., 2012), epilepsy (Miller et al., 2016), and emphysema (Torres-Sánchez et al., 2015)]. For example, emphysema may lead to cognitive decline via low peripheral oxygen saturation (≤ 88%) which has been strongly associated with a risk of cognitive impairment in patients with chronic obstructive pulmonary disease, and the use of home oxygen therapy has been associated with a reduction in that risk (Torres-Sánchez et al., 2015). Migraines may lead to cognitive impairment via central nervous system dysfunction underlying migraine pathophysiology (de Araújo et al., 2012).

Furthermore, people with physical diseases are more likely to have sleep problems (Koyanagi et al., 2014), and sleep problems, in turn, may give rise to cognitive impairment (Vanek et al., 2020).

In addition to this, some pairs of physical conditions may mutually influence each other to accelerate cognitive decline (e.g., heart disease, cerebrovascular disease) (Vassilaki et al., 2015), while drug interactions in people with multimorbidity may also increase the risk for cognitive decline (Koyanagi et al., 2018). In turn, cognitive impairment may increase suicidality owing to neurocognitive deficits that may lead to an incorrect appraisal of one's life situation and consequently poor decision-making (Pu et al., 2017).

Disability (% mediated 26.3%-37.5%) and pain (35.6%-38.0%) were also identified as key mediating variables. Physical multimorbidity can give rise to disability and pain owing to specific symptoms of individual physical conditions (e.g., stroke, arthritis), and these may increase the risk for suicidal thoughts/behavior not only via the specific suffering due to the symptoms but other factors such as social exclusion (Milner et al., 2019) and hopelessness (Hooley et al., 2014). Moreover, the desire to escape physical pain by death is often seen as the only solution, and it has been suggested that chronic exposure to pain and pain tolerance can reduce fear about death and increase the capability to carry out suicide (Jacob et al., 2018).

The large sample of UK adults and the identification of potential mediating variables in the physical multimorbidity/suicidal thought and behavior relationship are clear strengths of the present study. However, findings must be interpreted in light of the study limitations. First, the information used in this study was based on self-report, and therefore, social desirability

and recall bias may exist. Second, as cross-sectional data were used, the temporal ordering of physical multimorbidity and suicidality cannot be unequivocally determined. Third, data on the duration of physical illness, disease severity, and other specific information (e.g., cancer type) were not available, despite the fact that these could be important determinants of risk for suicidality. Future studies on this topic should consider incorporating this information. Finally, the variable on cognition was a crude measure consisting of only two answer options. Thus, it is possible for the mediated percentage to have differed if cognition was based on a different measure (e.g., Likert scale).

In conclusion, in this large sample of UK adults, physical multimorbidity was associated with a significantly higher odds for suicidal ideation and suicide attempts. Moreover, several potential mediators were identified, and these may serve as future targets for interventions that aim to prevent suicidality among people with physical multimorbidity.

## Figure legend

**Figure 1** Prevalence of suicidal ideation and suicide attempts by number of physical conditions

## Table legends

**Table 1** Sample characteristics (overall and by physical multimorbidity or suicidal ideation)

**Table 2** Prevalence of suicidal ideation and suicide attempts by absence or presence of physical diseases and physical multimorbidity

**Table 3** Association between number of physical conditions and suicidal ideation or suicide attempts (outcomes)

**Table 4** Mediators in the association between physical multimorbidity (i.e., ≥2 physical conditions) and suicidal ideation or suicide attempts

## Appendix legend

**Figure S1** Prevalence of physical diseases and each pair of physical diseases

## Declarations

**Informed consent and patient details:** Not applicable

**Declaration of Interest:** All authors confirm to have no actual or potential conflict of interests.

**Submission declaration and verification:** The article has not been published previously.

**Data availability statement:** The data used in this study can be obtained from the UK data archive (https://www.data-archive.ac.uk/).

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