Brief Report

Mental Health in Coronary Heart Disease (CHD) Patients: Findings from the UK Household Longitudinal Study (UKHLS)

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Abstract: Objectives: Mental health conditions in patients with coronary heart disease (CHD) are closely related to clinical outcomes. Thus, this study's goal is to investigate how CHD affects general and specific aspects of mental health. Methods: We analyzed data from Wave 10 Understanding Society: the UK Household Longitudinal Study (UKHLS), which were collected between 2018 and 2019. After removing people who had missing data, there were 450 participants who indicated that they have CHD, and 6138 age- and sex-matched healthy participants indicated that they were not clinically diagnosed with CHD. Results: The main findings were that participants with CHD had more mental health problems, as shown by the GHQ-12 summary score (t (449) = 6.00, $p < 0.001$, 95% C.I. [0.20, 0.40], Cohen's d = 0.30), social dysfunction and anhedonia, (t (449) = 5.79, $p < 0.001$, 95% C.I. [0.20, 0.40], Cohen's d = 0.30), depression and anxiety (t (449) = 5.04, $p < 0.001$, 95% C.I. [0.15, 0.33], Cohen's d = 0.24), and loss of confidence (t (449) = 4.46, $p < 0.001$, 95% C.I. [0.11, 0.30], Cohen's d = 0.21). Conclusion: This study implies that GHQ-12 is a valid assessment of mental health problems in CHD patients, and there is a need to consider how different aspects of mental health are affected by CHD rather than solely focusing on depression or anxiety problems alone in patients with CHD.

Keywords: mental health; GHQ-12; coronary heart disease

1. Introduction

The main cause of mortality globally is coronary heart disease (CHD) [1], which refers to conditions that occur when there is a buildup of plaque in the coronary arteries that supply blood to the heart muscle. This plaque buildup can cause the arteries to become narrow, reducing blood flow to the heart and increasing the risk of a heart attack. CHD puts a significant financial strain on the healthcare system [2]. Patients with CHD are more likely to develop mental health issues [3,4], including anxiety and depression [5,6], which have both been highly linked to poor outcomes in CHD patients [7–10]. These mental health conditions may not only increase the use of healthcare resources but can also result in disease deterioration [11].

Among commonly studied mental health conditions, including depression and anxiety, as pointed out by Carney and Freedland [12], several investigations have found that severe depression or clinically significant depression is common among patients with CHD. One study found that, among hospitalized patients with cardiac disease, 40.0% had clinically significant depression, as measured by a PHQ-9 score greater than 9. However, the prevalence of non-minimal depression (PHQ-9 score of 5 or greater) was even higher, at 78.4% [13]. Additionally, 13.6% CHD patients suffer from depression [14]. In comparison, only 3.8% of the general population suffers from depression, according to the WHO [15]. Similarly, anxiety is also very common among CHD patients. The prevalence of any anxiety illness is believed to be between 40% and 70% among CHD patients [16,17].

There are a few potential psychophysiological pathways that might explain the association between CHD and worse mental health. The first factor that may contribute to such an association might be the lifestyle factor. For instance, the Heart and Soul study [18–20] investigated the contribution of depression to the incidence of subsequent cardiovascular events in 1017 CHD patients. The results suggested that the association between mental health problems and cardiovascular events can be explained by factors such as physical inactivity, nonadherence to medication, and other behavioral factors of mental health. One possibility is inflation, as people with mental health problems are characterized by a sustained inflammatory state [21–23], and increased concentrations of a variety of inflammatory markers may have an important role in mediating the association between mental health and CHD [21–23]. Finally, endothelial dysfunction is linked to the majority of conventional cardiac risk factors that may be diagnosed in the early preclinical stages of atherosclerosis. Nitric oxide is normally produced by the vascular endothelium to maintain vascular tone and prevent smooth muscle cell proliferation, leukocyte adhesion, and platelet aggregation. Endothelial dysfunction may happen when the amount of endothelial nitric oxide is diminished, allowing the atherosclerotic process to proceed unabated [24]. Even in the absence of additional cardiac risk factors, evidence suggests that poor mental health is related to endothelial dysfunction [25–29].

The psychometric properties of the GHQ-12 have been examined in the literature [30–35]. Moreover, research suggests that the GHQ-12 is characterized by good specificity, reliability, and sensitivity [36,37]. Even though GHQ-12 was designed to be a unidimensional measure of mental health, there is debate about whether it should be utilized on a unidimensional or multidimensional scale. Furthermore, there is a lot of evidence for the GHQ-12 three-factor model among other factor solutions [38–44], including social dysfunction and anhedonia, depression and anxiety, and loss of confidence. The strong correlation between these components [30,40,42] is a common argument used to support the usage of the unidimensional GHQ-12 over the factor solution. Recent research utilizing simulated data, however, has shown that imposing a simplistic framework may artificially exaggerate correlations between modeled elements [45]. As a result, Griffith and Jones [46] warned that "taking these correlations as justification for unidimensionality risks a self-fulfilling prophecy of simplicity begetting simplicity" (p. 3). Given these disagreements, we investigated how the GHQ-12 unidimensional and multidimensional structures are affected by CHD.

While earlier research looked at how CHD affects mental health, with a major focus on sadness and anxiety, far less is understood about how CHD affects the general and specific aspects of mental health. As a result, we aimed to evaluate these CHD effects.

2. Methods

2.1. Data

For the present study, data from Wave 10 of the UK Household Longitudinal Study (UKHLS) [47], conducted between 2018 and 2019, were utilized. The initial sample included participants who self-reported having CHD (n = 450), while the remaining sample of age- and sex-matched individuals (n = 6138) reported no clinical diagnosis of CHD after the exclusion of those with missing data. The ratio of CHD participants and healthy people was slightly higher than previous studies (i.e., [48]), which could be explained by the missing data exclusion.

2.2. Measures

2.2.1. CHD

The reliability of self-reported cardiovascular disease has been established in prior research (e.g., [49]). In the present study, participants were asked to respond to the following question as a means of indicating whether they had coronary heart disease: "Has a doctor or other health professional ever told you that you have any of these conditions? Coronary heart disease." The response options included "Yes/No/Don't know". Participants who answered "Don't know" were removed from further analysis.

2.2.2. Mental Health

In this study, mental health was assessed using the GHQ-12, a unidimensional measure consisting of 12 items [50]. Responses on the Likert scale ranged from 0 ("Not at all") to 3 ("Much more than usual"). A summary score across all 12 items was calculated to indicate their overall mental health, with higher scores indicating poorer mental health. The GHQ-12 was rated on a scale of 1 ("Not at all") to 4 ("Much more than usual") for the purpose of a factor analysis.

2.2.3. Demographic Variables

Age, sex, monthly income, education, marital status, and residence were all demographic variables in the linear models.

2.3. Analysis
2.3.1. Factor Model

In the present study, a confirmatory factor analysis (CFA) with oblique rotation was performed on the General Health Questionnaire-12 (GHQ-12) using MATLAB 2018 software. The analysis was conducted with a prespecified three-factor structure, which included social dysfunction and anhedonia, depression and anxiety, and loss of confidence. Subsequently, both the GHQ-12 summary score and component scores were standardized with a mean of 0 and a standard deviation of 1 for further analysis. This was done to ensure differences between groups were presented in Cohen's d units.

2.3.2. Linear Models

In this study, a predictive normative modeling approach was utilized to control for the impact of unbalanced factors on mental health between healthy individuals and those with CHD, such as demographics. Firstly, four generalized linear models were constructed using demographics as predictors and the GHQ-12 summary scores, social dysfunction and anhedonia, depression and anxiety, and loss of confidence as the dependent variables. These models were based on data from individuals who did not report having CHD. Secondly, the CHD patients' demographics were incorporated into the models to predict their anticipated GHQ-12 summary scores, social dysfunction and anhedonia, depression and anxiety, and loss of confidence. Finally, one-sample *t*-tests were performed to assess the differences between the actual and predicted scores.

3. Results

Table 1 displays the descriptive statistics. The CFA produced three interpretable factors, including social dysfunction and anhedonia, depression and anxiety, and loss of confidence. Table 2 shows the factor loadings for each question.

The current study found the main effects of age (F(1, 6131) = 39.95, $p < 0.001$, $\eta^2 = 0.01$), sex (F(1, 6131) = 58.36, $p < 0.001$, $\eta^2 = 0.01$), monthly income (F(1, 6131) = 32.22, $p < 0.001$, $\eta^2 = 0.01$), and legal marital status (F(1, 6131) = 143.56, $p < 0.001$, $\eta^2 = 0.00$) on the GHQ-12 summary scores. Similarly, there was the main effects of sex (F(1, 6131) = 8.91, $p < 0.01$, $\eta^2 = 0.00$), monthly income (F(1, 6131) = 14.18, $p < 0.001$, $\eta^2 = 0.00$), and legal marital status (F(1, 6131) = 13.02, $p < 0.001$, $\eta^2 = 0.00$) on social dysfunction and anhedonia. Moreover, there was the main effects of age (F(1, 6131) = 97.85, $p < 0.001$, $\eta^2 = 0.02$), sex (F(1, 6131) = 95.06, $p < 0.001$, $\eta^2 = 0.02$), monthly income (F(1, 6131) = 15.13, $p < 0.001$, $\eta^2 = 0.00$), and legal marital status (F(1, 6131) = 11.00, $p < 0.001$, $\eta^2 = 0.00$) on depression and anxiety. Finally, there was the main effects of age (F(1, 6131) = 23.73, $p < 0.001$, $\eta^2 = 0.00$), sex (F(1, 6131) = 20.56, $p < 0.001$, $\eta^2 = 0.00$), monthly income (F(1, 6131) = 49.77, $p < 0.001$, $\eta^2 = 0.01$), and legal marital status (F(1, 6131) = 27.60, $p < 0.001$, $\eta^2 = 0.00$) on loss of confidence. However, the main effect of age was not significant.

The main finding was that CHD patients have worse overall mental health, as indicated by the GHQ-12 summary scores (t (449) = 6.00, $p < 0.001$, 95% C.I. [0.20, 0.40], Cohen's d = 0.30), social dysfunction and anhedonia (t (449) = 5.79, $p < 0.001$, 95% C.I. [0.20, 0.40],

Cohen's d = 0.30), depression and anxiety (t (449) = 5.04, $p < 0.001$, 95% C.I. [0.15, 0.33], Cohen's d = 0.24), and loss of confidence (t (449) = 4.46, $p < 0.001$, 95% C.I. [0.11, 0.30], Cohen's d = 0.21). Figure 1 shows the means and standard errors of the projected and actual standardized scores.

Table 1. The demographic characteristics for the healthy controls and CHD patients.

	Healthy Controls		CHD Patients	
	Mean	S.D.	Mean	S.D.
Age	68.47	8.22	68.29	11.60
Income (monthly)	£1832.58	£1570.07	£1699.32	£1170.78
	N	%	N	%
Sex				
Male	4167	67.89	308	68.44
Female	1971	32.11	142	31.56
Education				
Below college	4330	70.54	351	78.00
College	1808	29.46	99	22.00
Legal marital status				
Single	2048	33.37	178	39.56
Married	4090	66.63	272	60.44
Residence				
Urban	4348	70.84	323	71.78
Rural	1790	29.16	127	28.22

Table 2. The factor loadings for the three-factor structure of the GHQ-12.

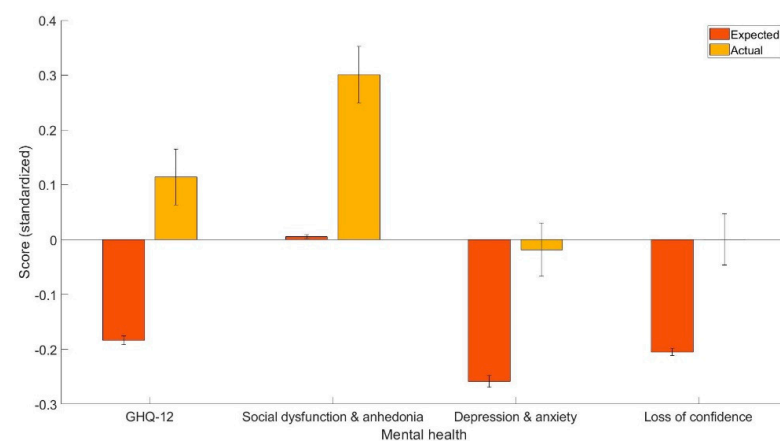| GHQ-12 Items	Social Dysfunction and Anhedonia	Depression and Anxiety	Loss of Confidence
Concentration	**0.53**	0.25	−0.10
Loss of sleep	0.00	**0.66**	0.05
Playing a useful role	**0.67**	−0.16	0.16
Constantly under strain	**0.79**	−0.14	0.00
Problem overcoming difficulties	−0.01	**0.88**	−0.07
Unhappy or depressed	0.08	**0.56**	0.21
Losing confidence	**0.68**	0.22	−0.125
Believe worthless	**0.71**	−0.03	0.04
General happiness	0.013	**0.53**	0.34
Capable of making decisions	0.00	0.23	**0.70**
Ability to face problems	0.10	0.02	**0.74**
Enjoy day-to-day activities	**0.56**	0.10	0.10

Figure 1. The expected and actual scores (standardized) for GHQ-12, social dysfunction and anhedonia, depression and anxiety, and loss of confidence.

4. Discussion

The current study sought to evaluate how CHD affects the general and specific aspects of mental health. By using a CFA and predictive normative modeling approach, the current study (1) identified the underlying factors of the GHQ-12, including social dysfunction and anhedonia, depression and anxiety, and loss of confidence, and (2) found that the patients had more overall mental health problems, as well as dysfunction and anhedonia, depression and anxiety, and loss of confidence.

In the current study, the CFA generated three factors labeled as social dysfunction and anhedonia, depression and anxiety, and loss of confidence. The current study's three-factor structure solution is substantially compatible with prior research that identified three components in GHQ-12 [38–44]. Furthermore, as indicated in Table 1, the factor loadings in our investigation appeared to be high.

The result that CHD has a negative impact on patients' overall mental health is mostly consistent with the assumption that mental health commodities are relatively frequent in patients. Furthermore, CHD patients had more social dysfunction and anhedonia, which is a novel finding, given that previous research has shown that anhedonia can independently predict patients' health and more somatic and cognitive symptoms, as well as the combined endpoint of adverse clinical events and mortality one year after an acute coronary syndrome [51] and in patients following coronary artery stent implantation [52]. This result is also consistent with one previous study that found heart failure to be associated with poor psychosocial function [53]. In addition, these associations were still held after taking into account depression and the severity of depression. The finding that CHD patients have worse depression and anxiety is also consistent with previous studies that found the prevalence of depression and anxiety higher than the general population prevalence (see [12,54] for reviews). Finally, the current study also found that CHD patients have worse confidence compared with people who do not have CHD, which is of particular importance given that confidence in patients is closely related to clinical outcomes. Moreover, the effect sizes of the different dimensions of mental health were different, which may imply that the dimensions of mental health are affected by CHD differently; thus, there is a need to look at the specific dimensions of mental health in addition to general mental health.

Despite the present study's advantages, there were several drawbacks. First, because the current study was cross-sectional, it could not demonstrate a causal link, because the interaction between CHD and mental health problems might be completely bidirectional. To demonstrate the temporal order, future research should take a longitudinal approach. Second, our study relied on self-reported measures, which are susceptible to self-reported bias. Future research may need to employ more objective metrics, such as clinical assessments, to determine whether the present findings are still valid. Finally, our study only included individuals from the UK, making it difficult to extrapolate the current findings to other countries.

5. Conclusions

To summarize, by using a CFA and predictive normative modeling approach, the current study replicated the three underlying structures of the GHQ-12 and found that the GHQ-12 summary scores revealed that patients have more overall mental health issues (Cohen's d = 0.30), social dysfunction and anhedonia (Cohen's d = 0.30), depression and anxiety, (Cohen's d = 0.24), and loss of confidence (Cohen's d = 0.21). This study suggests that GHQ-12 is a meaningful measure of mental health problems in CHD patients and that there is a need to investigate how different aspects of mental health are affected by CHD rather than focusing primarily on depression or anxiety difficulties in CHD patients. Clinicians should develop interventions that improve mental health in people with CHD, which can then lead to better outcomes.

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