

*Original Research*

# Self-reported Physical Health as a Mediator of the Effects of BMI on Depression among People with Multiple Chronic Conditions

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## Abstract

**Background:** The current study examined whether the association between body mass index (BMI) and symptoms of depression is mediated by self-reported physical health among Chinese people with multiple chronic conditions (MCCs). **Methods:** This was a secondary analysis based on a previous cross-sectional survey using the Hospital Anxiety and Depression Scale (HADS) and Short Form-12 (SF-12). A convenience sample of Chinese people with MCCs ( $n = 351$ ) was recruited and a mediation effect model using SPSS PROCESS was employed. **Results:** The results showed that self-reported physical health acted as a full mediator in the association between BMI and depression only for men with MCCs. **Conclusions:** The findings of this study suggest that decreased physical health should be of primary importance in the management of MCCs. Further intervention addressing weight control could be a strategy of particular interest for improving the mental health of people with MCCs.

**Keywords:** body mass index; depression; multiple chronic conditions; obesity; physical health

## 1. Introduction

Obesity is a medical condition in which there is too much fat in a person's body. Generally, people are considered obese when their body mass index (BMI) is over 30 kg/m<sup>2</sup>. This index is also used to indicate the level of risk for disease (morbidity) and death (mortality) at the population level. Obesity is suggested to be a significant population health problem across countries. China, like many other developing countries, is facing a national obesity epidemic and the following challenges. Data from the 2013–2014 China Chronic Disease and Risk Factor Surveillance (CCDRFS) showed that the overall prevalence of general obesity among Chinese adults was 14% (95% Confidence Interval (CI), 13.4% to 14.7%), and that of abdominal obesity was 32% (95% CI, 30.5% to 32.6%) [1].

Research has shown that physical health and obesity are independently and inversely related [2]. Obesity is associated with a range of physical health outcomes such as cancers, type 2 diabetes, hypertension, and stroke [3]. Obesity is highly associated with multiple chronic conditions (MCCs) [4]. MCCs are commonly suggested as the coexistence of two or more chronic health conditions in a person. MCCs have negative effects on people's health [5] and result in a considerable financial burden [6]. According to the China Health and Retirement Longitudinal Study (CHRLS), the prevalence of MCCs was more than 40% among people over 50 years old. Women groups and urban residents are more vulnerable to MCCs [7].

Obesity and depression have an overlapping pathoetiology [8] and both of them are public health issues [9]. Research has linked being underweight or overweight/obese

to the development of depression and such an association has been investigated at the cross-sectional level: A cross-sectional survey with a representative sample of the German population showed that obese people reported more symptoms of depression than people in other BMI groups [10]; a national survey of Chinese middle-aged and older adults found a significant positive association between BMI and depression in males, but no association for females [11]; another study concluded that there was a significant U-shaped trend in the association between BMI groups and depression [12]. Although cross-sectional findings are informative, the exact mechanisms between depression and obesity is under research. The association between obesity and depression is bidirectional, which means that obesity increases the risk of depression and depression also predicts the development of obesity [13,14]. A meta-analysis has confirmed this reciprocal link [15].

However, much remains to be learned and confirmed about the extent to which physical health adjustments reduce or change the association between BMI and psychological distress, especially for people with MCCs. Knowledge about this relationship will enable cost-effective prevention for the population with MCCs.

The aims of this study were (1) to analyze the association between BMI, physical health, and depression, and (2) to identify whether the association between BMI and depression is mediated by physical health in Chinese people with MCCs.

The research hypotheses were as follows: (1) There is a significant association between BMI conditions, self-reported physical health, and symptoms of depression, and



(2) The impact of BMI conditions on symptoms of depression is mediated by self-reported physical health.

## 2. Materials and Methods

This was a secondary analysis of a previous cross-sectional study aimed at understanding the coping mechanisms of individuals with MCCs. Details of the methods and sampling process were described in the first phase of this project, which was conducted in Bengbu, Anhui, China, from November 2017 to May 2018. The details of the previous survey have been published [16].

### 2.1 Sample

A total of 351 participants completed a detailed questionnaire that included sociodemographic variables and clinical variables, in addition to the Hospital Anxiety and Depression Scale (HADS) and Short-Form 12 (SF-12).

### 2.2 Measurements

The sociodemographic variables and clinical variables included age, sex, MCCs-related variables, and BMI.

The criteria of weight status for Chinese adults were used in this study. The criteria in the Guidelines for the Prevention and Control of Overweight and Obesity in Chinese Adults were applied to those aged 18–60 years: BMI was calculated by dividing weight (in kilograms) by height (in meters squared). A BMI between 18.5 and 23.9 was considered normal; a BMI less than 18.4 was considered underweight; a BMI between 24.0 and 27.9 was considered overweight; a BMI above 28.0 was considered obese. Thus all the participants were categorized into four groups based on their BMIs [17].

The HADS was used to assess the participants' levels of anxiety and depression in this study. This scale has 14 items consisting of two subscales of anxiety and depression. Each item was scored on a four-point Likert scale (0–3). The total scores for each subscale ranged from 0 to 21. The higher the scores are, the greater the levels of anxiety and depression. The HADS has been validated and shown to be reliable in Chinese people with chronic health conditions [18]. In the current study, Cronbach's alpha was 0.84 for the HADS.

The SF-12 was used to assess the participants' levels of physical health in this study. This scale has 12 items consisting of two health-related domains: the Physical Components Summary (PCS) and the Mental Components Summary (MCS). The two domains were calculated according to the SF scoring system and the scores ranged from 0 to 100. A higher score suggests a better level of physical and mental health. The SF-12 has been validated and shown to be reliable in the Chinese population [19]. In the current study, Cronbach's alphas were 0.82 for the PCS and 0.69 for the MCS.

### 2.3 Data Collection

Potential participants were recruited via advertisements at the outpatient clinics of the study venue. The eligible participants were asked to complete the survey at the study venue, which was administered by the primary author and/or the research assistants. The participants spent, on average, 15 minutes completing the survey.

### 2.4 Data Analysis

All analyses were conducted using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA), along with macros SPSS PROCESS version 3.5. The results of the participants' characteristics are described as the mean  $\pm$  S.D., numbers, and percentages. The normality of the data was checked by the Kolmogorov-Smirnov test. Pearson's  $r$  was used to assess the association between variables.

The mediation effect model using SPSS PROCESS was performed to determine the mediating effect of a single mediator, physical health, on the relationship of BMI and depression [20]. The total scores for BMI, the PCS, and the symptoms of depression were used as continuous measures of obesity, physical health, and depression in this study. Age, the duration of MCCs, and the number of chronic health conditions were included in the mediation analysis as covariates. The indirect effect was tested by using a bias-corrected bootstrapping procedure with 5000 samples. An effect was regarded as significant if the confidence interval (95% CI) did not include "0" signals.  $p < 0.05$  was regarded as significant for all analyses.

Given that there is a sex gap for depression [21], this study performed the mediation analyses separately for men and women.

## 3. Results

### 3.1 Sample Characteristics

Of the total participants (Men = 196), the mean BMI score was 23.79 (2.74), the mean depression score was 7.42 (3.39), and the mean PCS score was 37.92 (11.78). There were significant differences between the sex groups for the variable of depression (see Table 1).

### 3.2 Relationships among BMI, Depression, and Physical health

In the male group, increased age was correlated with more chronic health conditions ( $p < 0.001$ ), longer-term MCCs ( $p = 0.001$ ), impaired physical health ( $p < 0.001$ ) and more symptoms of depression ( $p = 0.024$ ). BMI was negatively associated with the duration of MCCs ( $p = 0.045$ ) but positively associated with physical health ( $p = 0.006$ ). Poor physical health was associated with more chronic health conditions ( $p < 0.001$ ), longer-term MCCs ( $p = 0.001$ ), and more symptoms of depression ( $p < 0.001$ ) (see Table 2).

In the female group, increased age was correlated with more chronic health conditions ( $p = 0.004$ ), longer-term

**Table 1. Characteristics of the observed variables (n = 351).**

	Age		Number of MCCs		Duration of MCCs		BMI		Physical health		Depression	
Male (n = 176)	59.86	14.63	2.19	0.45	2.52	1.00	23.79	2.74	38.08	11.44	7.80	3.48
Female (n = 175)	57.91	14.49	2.21	0.46	2.41	1.05	23.49	3.51	37.77	12.14	7.03	3.26
Total (n = 351)	58.89	14.57	2.20	0.45	2.47	1.03	23.64	3.14	37.92	11.78	7.42	3.39
F	1.57		0.07		1.03		0.81		0.06		4.61*	
p value	0.211		0.796		0.311		0.368		0.804		0.032	

\* Statistically significant *p* values ( $p < 0.05$ ).

**Table 2. Correlations of the observed variables in the male group (n = 176).**

		1.	2.	3.	4.	5.	6.
1. Age	coefficient	1	0.272**	0.254**	-0.097	-0.360**	0.170*
	<i>p</i> value		0.000	0.001	0.199	0.000	0.024
2. Number of MCCs	coefficient	0.272**	1	0.155*	-0.039	-0.250**	0.061
	<i>p</i> value	0.000		0.040	0.605	0.001	0.420
3. Duration of MCCs	coefficient	0.254**	0.155*	1	-0.151*	-0.148	-0.045
	<i>p</i> value	0.001	0.040		0.045	0.050	0.550
4. BMI	coefficient	-0.097	-0.039	-0.151*	1	0.206**	-0.020
	<i>p</i> value	0.199	0.605	0.045		0.006	0.792
5. Physical health	coefficient	-0.360**	-0.250**	-0.148	0.206**	1	-0.277**
	<i>p</i> value	0.000	0.001	0.050	0.006		0.000
6. Depression	coefficient	0.170*	0.061	-0.045	-0.020	-0.277**	1
	<i>p</i> value	0.024	0.420	0.550	0.792	0.000	

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

MCCs ( $p < 0.001$ ), impaired physical health ( $p < 0.001$ ), and more symptoms of depression ( $p < 0.04$ ). BMI was positively associated with the number of MCCs ( $p = 0.001$ ) and the duration of MCCs ( $p = 0.02$ ). Poor physical health was associated with more chronic health conditions ( $p = 0.001$ ), longer-term MCCs ( $p < 0.001$ ), and more symptoms of depression ( $p < 0.001$ ) (see Table 3).

### 3.3 Mediation Models for Depression

A mediation model was built to examine whether self-reported physical health acted as an indirect pathway between BMI and depression across sex, after controlling for sociodemographic characteristics and MCCs-related variables.

When testing the mediator role in the male group, no significant association was found between BMI and depression in the total effect model ( $b = -0.0202$ , 95% CI =  $-0.2108, 0.1703$ ) or the direct effect model ( $b = 0.0359$ , 95% CI =  $-0.1526, 0.2244$ ). The results of the indirect effect model indicated that physical health fully mediated the relationship between BMI and depression ( $b = -0.0562$ , 95% CI =  $-0.1167, -0.0118$ ). In the female group, all three effect models were insignificant (see Table 4).

## 4. Discussion

This study examined the association between BMI and depression as well as the potential mediating effects of physical health on this association in people with multiple chronic conditions. Before turning to the major findings, this study replicated previous findings regarding the association between negative physical health outcomes and symptoms of depression [22–24], suggesting that decreased physical health could be a possible risk factor for the development of possible depression or vice versa.

QoL is a useful indicator of health status and a predictor of morbidity and mortality [25]. Previous research indicated that the general health status evaluated by the EuroQol-5Dimension-5Level (EQ-5D-5L) was a significant mediator in the association between BMI and depression in the general population. In line with this finding, we found that, in people with MCCs, self-reported physical health evaluated by the SF-12 mediated the relationship between BMI and depression, suggesting that an improvement in physical health might contribute to preventing or reducing depression in this population. Our results differ from those of Pokrajac-Bulian, Kukić, and Bašić-Marković that identified the mediating associations only in female participants [26]. A possible explanation for this inconsistency might be sampling variation and sampling distributions. In addition, the relationship between BMI and health-related indicators may be impacted by people's sociodemographic and clinical factors. For example, factors such as the sever-

**Table 3. Correlations of the observed variables in the female group (n = 175).**

		1.	2.	3.	4.	5.	6.
1. Age	coefficient	1	0.215**	0.293**	0.081	-0.496**	0.156*
	p value		0.004	0.000	0.285	0.000	0.039
2. Number of MCCs	coefficient	0.215**	1	0.372**	0.258**	-0.260**	-0.012
	p value	0.004		0.000	0.001	0.001	0.878
3. Duration of MCCs	coefficient	0.293**	0.372**	1	0.183*	-0.297**	0.149*
	p value	0.000	0.000		0.015	0.000	0.049
4. BMI	coefficient	0.081	0.258**	0.183*	1	-0.142	0.054
	p value	0.285	0.001	0.015		0.061	0.482
5. Physical health	coefficient	-0.496**	-0.260**	-0.297**	-0.142	1	-0.429**
	p value	0.000	0.001	0.000	0.061		0.000
6. Depression	coefficient	0.156*	-0.012	0.149*	0.054	-0.429**	1
	p value	0.039	0.878	0.049	0.482	0.000	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

**Table 4. Effects on BMI and depression with physical health as a mediator.**

	Male group (n = 176)					Female group (n = 175)						
	Effect	Boot SE	t	p value	95% CI		Effect	Boot SE	t	p value	95% CI	
					LLCI	ULCI					LLCI	ULCI
Total effect	-0.0202	0.0965	-0.2096	0.8342	-0.2108	0.1703	0.0405	0.0723	0.5603	0.5760	-0.1023	0.1833
Direct effect	0.0359	0.0955	0.3762	0.7072	-0.1526	0.2244	0.0153	0.0662	0.2314	0.8173	-0.1154	0.1460
Indirect effect	-0.0562	0.0266			-0.1167	-0.0118	0.0252	0.0326			-0.0430	0.0870

Adjusted for age, number of MCCs, and duration of MCCs.

ity of depression, the severity of obesity, sex, and chronic health conditions may affect the relationship and may lead to conflicting results.

We found that male participants reported more symptoms of depression than their female peers [27]. There is an assumption that sex differences exist in depression and therefore the analyses were performed separately by sex. The findings of this study were congruent with this assumption [21]. Based on our findings, a portion of the variance in symptoms of depression in the male participants could be explained by their BMI. Men are more likely to be impacted by the association between BMI and physical health, in contrast with women for whom such an impact is limited.

Past studies [12,28,29] showed that BMI groups were nonlinearly (U-shaped) associated with depression. Both obesity and underweight were associated with an increased level of depression scores, even after controlling for various sociodemographic variables. The results of this study emphasized the importance of physical health in this relationship. Further research may consider distinguishing between different BMI groups when exploring the nature of the association with depression.

Several limitations should be pointed out in the current study. The symptoms of depression were measured by self-report questionnaires; thus, the reporting bias may have occurred. The HADS is a valid instrument for measuring symptoms and depression and anxiety, but it cannot be used as a diagnostic instrument for mental disorders. The

lack of some significant sociodemographic variables such as educational level, income level, and marital status in the mediator models might have resulted in bias. Additionally, differences in self-reported QoL could be significant across people with different combinations of MCCs [30], and the current study did not investigate the potential clusters of these chronic health conditions.

## 5. Conclusions

This study was the first attempt to clarify the mediating role of self-reported physical health in the association between BMI and symptoms of depression among Chinese people with MCCs. The findings of this study indicate that the impairment of physical health should be of the utmost importance in the management of MCCs and may contribute to the development of effective interventions for mental health issues in people with MCCs.

## Author Contributions

CC designed the research study. CC and JB performed the research. JB analyzed the data. CC and JB wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

This study was approved by the Human Research Ethics Committee of the University of Newcastle and the

study venue. Each participant signed the informed consent and was told that the participation was voluntary and the information would be kept secure. This project was approved by the Human Research Ethics Committee of the University of Newcastle (H-2017-0378) and the study venue approved this survey.

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## Conflict of Interest

The authors declare no conflict of interest.

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