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Self-management and psychological resilience moderate the relationships between symptoms and health-related quality of life among patients with hypertension in China

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Abstract

Purpose To examine whether and how self-management and psychological resilience could moderate the relationships between symptoms and health-related quality of life (HRQoL) among hypertensive patients in China.

Methods This was a cross-sectional study of 220 participants recruited from January to May, 2018. Demographic and clinical information were obtained from medical records and by patient interview. The Chinese version of 17-item Hypertension-specific Symptom Scale, 21-item Self-Management Scale, and 10-item Connor-Davidson Resilience Scale (CD-RISC-10) as well as Short Form 12 Health Survey (SF-12) were used to collect information in this research. The moderation effects of self-management and psychological resilience were explored using the PROCESS macro for SPSS.

Results Among all patients, 128 (58.2%) were female, 106 (48.2%) had a bachelor degree or higher, and 133 (60.5%) had moderate to severe Charlson Comorbidity Index. Both self-management and psychological resilience were negatively correlated to symptoms ($r=-0.259$, $p<0.001$; $r=-0.282$, $p<0.001$) but positively correlated to physical ($r=0.316$, $p<0.001$; $r=0.344$, $p<0.001$) and mental ($r=0.273$, $p<0.001$; $r=0.309$, $p<0.001$) HRQoL. After controlling for potential covariates, self-management could moderate the associations between symptoms and physical HRQoL ($p=0.041$, $\Delta R^2=0.010$), while psychological resilience could moderate the relationships between symptoms and mental HRQoL ($p=0.02$, $\Delta R^2=0.010$).

Conclusions For hypertension patients, HRQoL is dependent on the severity of symptoms, engagement of self-management behaviors, and psychological resilience, which should be carefully considered when to improve patients' HRQoL by health care providers.

Keywords Health-related quality of life · Psychological resilience · Self-management · Moderation effects · Hypertension

Introduction

Hypertension is one of the most preventable causes of death in the world [1]. The estimated global age-standardized prevalence of hypertension was 32% among adults over 20 in 2011–2014 [2]. The prevalence of hypertension in low-income and middle-income countries was much higher than that in high-income countries [3]. Successive population surveys on hypertension in China have reported an increasing prevalence of hypertension in the past 30 years, and it was estimated that about 292 million Chinese patients carried a diagnosis of hypertension during 2013–2014 [4]. In 2013, hypertension accounted for 28% of all deaths and 15.0% of deaths of total disability-adjusted life years in China [4]. Along with long disease duration and stress burden, hypertensive patients had lower health-related quality of life (HRQoL) compared with normotensive individuals [5].

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Symptoms are a significant marker of improvement or exacerbation of diseases, which is also the basis for triage, diagnosis, and treatment [6]. Although hypertension is thought to be symptomless, cognitive changes, mood alterations as well as symptoms attributed to elevated blood pressure (BP) and drug side effects have been reported in previous research [7, 8]. Foremost, being diagnosed with hypertension means that patients need to comply with long-term treatment and substantial lifestyles changes, which might bring them with stress and affective distresses (defined as labeling effects) [9]. The presence of symptoms, regardless of their source, is strongly associated with patients' HRQoL [10, 11]. According to Tikhonoff [12], the act of labeling someone as hypertensive may result in increased psychological distresses by adopting a sick role, and affective distresses manifesting as depression are negatively correlated to both physical and mental quality of life. Bardage [13] also demonstrated that the experience of adverse effects related to anti-hypertensive treatment deteriorate patients' well-being. Erickson [14] stated that higher symptoms numbers and symptoms distress score are strongly associated with lower HRQOL among hypertensive patients; these factors are stronger predictors of HRQoL than any other demographic and disease variables. Symptoms monitoring and management are pivotal to improve patients' HRQoL. Besides, finding modifiable factors that could influence the strength and direction of the relationships between symptoms and HRQoL would further improve patients' HRQoL.

Self-management is where patients, along with their family, community, and health care professionals, take greater responsibility for health decisions and actively engage in behaviors that might benefit their diseases [15]. Patients with optimal self-management show better adaption to patients' roles and present with clear illness perception [16] and illness acceptance [17]. A number of studies suggested that self-management could be crucial for patients to achieve blood pressure control and to prevent complications such as heart failure, stroke, and to improve patients' overall health status [18]. Although HRQoL is an important outcome in the management of hypertension, the literature is limited regarding the effects of self-management on HRQoL in hypertensive patients, and available studies yield conflicting results. The study by Wang et al. [19] indicated that self-management efficacy, as the intrinsic motivation of self-management, has a significant impact on HRQoL, but a cohort study by Kazemi Shishavan et al. [20] demonstrated that the total self-management score is not significantly correlated to HRQoL among hypertensive patients. A nurse-led hypertension management program by Zhu et al. [21] revealed that patients' HRQoL does not improve along with improvement of patients' self-management capability. Considering the controversial results, a recent research performed by Kessing et al. [22] suggested that symptoms, especially psychological distresses, should be the focus of the efforts to address the relationships between self-management and HRQoL among cardiovascular patients. This would provide new insights to further clarify the relationships between self-management and HRQoL and achieve better management of patients with hypertension.

According to the American Psychological Association (2014), psychological resilience was defined as "the process of adapting well in the face of adversity, trauma, tragedy, threats or even significant sources of stress" [23]. It is a time-varying psychological characteristics of development and believed to be an inner strength but can interact with the external environment [23]. Low resilience in ones' early life could entail hypertension in his or her adulthood [24]. Psychological resilience is also a pivotal factor associated with better HRQoL. As reported by Ovidiu et al. [25], more resilient cancer patients have significantly better HRQoL. A study by Zhang et al. [26] also demonstrated that better psychological resilience could improve patients' HRQoL through both direct and indirect ways.

Demographic and social characteristics are non-modifiable factors involved in HRQoL, while symptoms experience, self-management, and psychological resilience are, at least in part, modifiable and should be the focus of the efforts to improve patients' HRQoL. Unfortunately, the literature is scarce regarding the effects of modifying these factors on HRQoL in hypertensive patients; the available studies only examined these factors as independent predictors of HRQoL and overlooked the potential interaction effects among symptoms, self-management, and psychological resilience. In fact, symptoms are not independent from self-management and psychological resilience. For example, patients' symptoms perception could motivate them to perform doctoring-behaviors and to improve their adherence to pharmacological and non-pharmacological therapies [27], but the consequent depression, anxiety, cognitive decline, and therapy side effects can blunt self-management by decreasing patients' motivation to engage in healthy behaviors [28]. In addition, lower psychological resilience is strongly correlated to depression and related affective, cognitive, and somatic symptoms [29]. The limitations of previous literature on the effects of modifying these factors on HRQoL of hypertensive patients might hinder the implementation of effective intervention programs for patients' HRQoL.

Wilson-Cleary model is one of the most widely cited conceptual framework of HRQoL and defines HRQoL as a multidimensional construct incorporating physiological factors, symptoms status, functional status, and quality of life) [30]. Referencing to the W–C model, the patients' perception of symptoms could influence HRQoL and these relationships might be modified by the patients' individual and social characteristics. Given that self-management and psychological resilience are functions of both social and

individual factors [23, 31], we hypothesized that self-management and psychological resilience could moderate the relationships between symptoms and both physical, mental HRQoL among hypertensive patients.

Hence, the specific aims of this study were: (1) to examine whether self-management and psychological resilience could moderate the relationship between hypertension symptoms and HRQoL; and (2) to explore how self-management and psychological resilience could moderate the effects of symptoms on HRQoL among hypertensive patients in China.

Methods

Sample and procedure

This was a cross-sectional study conducted at the Tianjin Medical University General Hospital (China) from January to May, 2018. The estimated sample size was 73, based on a moderate *f*2 effect size of 0.15, α of 0.05, and power of 0.90 using G*Power [32]. A total of 220 hypertensive patients were recruited. Some of the recruited patients were referred by their general practitioners (in community clinics) to seek advanced treatment in the cardiovascular outpatient clinic when their diseases exacerbated, and others were attending to the cardiovascular outpatient clinic to undergo routine examination. Patients were eligible if they met the following criteria: (1) had a documented diagnosis of hypertension of at least 3 months duration; (2) were prescribed one or more anti-hypertensive drugs; (3) > 18 years of age; and (4) able to understand and write Chinese. The exclusion criteria were: patients with (1) active and severe infection as well as malignant tumors; (2) impaired cognitive abilities; or (3) inherent or non-disease induced disability. All data were collected by two post graduate researchers with excellent communication skills. The study was approved by the Research Ethics Committees of Tianjin Medical University and Tianjin Medical University General Hospital. All participants signed the informed consent form.

Measurements

Demographic and clinical characteristics

Demographic and clinical information were obtained from medical records and by patient interview. The sociodemographic information included age, gender, marital status, income, education level, employment status, smoking status, and alcohol intake. The income was categorized into two classes, < 2000 versus ≥ 2000 renminbi (RMB) according to the consumption expenditure and per capita income announced by the Tianjin Bureau of Statistics. The clinical characteristics consisted of duration of hypertension, co-morbidity status, blood pressure (BP) classification, and family history of cardiovascular diseases as well as body mass index (BMI). Co-morbidity status was evaluated with the Charlson Comorbidity Index (CCI). Patients were divided into two groups: mild, with CCI scores of 0–2; and moderate to severe, with CCI ≥ 3 [33]. BP was measured first before the other physical examinations when patients visited the physician after at least a 5-min rest, according to the recommendation of the newest guideline for prevention and treatment of hypertension in China [34], using an oscillometric device (Omron Omron Corp., Kyoto, Japan).

Hypertension-specific symptoms scale

Symptoms were measured by the Hypertension-specific Symptom Scale. The scale includes 17 items with regard to general symptoms, side effects of anti-hypertensive treatment, and mental distress caused by label effects of hypertension. Each item is rated from 5 (very much) to 1 (none), with a higher score reflecting severe symptoms status. Cronbach's α is 0.79 and the test–retest reliability is 0.75 [35]. In the present study, the Cronbach's α was 0.77.

Self-management

The Chinese version of the 21-item Self-management Scale was adopted to evaluate participants' entire self-management capability from the aspects of pharmacy, exercise, living habits, and risk factors management. Cronbach's α of the scale is 0.854, which shows high reliability [36]. Each item is rated on a five-point Likert response (1 = never, 5 = always). A higher score is associated with patients' higher capability to perform self-management. In the present study, the Cronbach's α was 0.82.

Psychological resilience

Psychological resilience (i.e., the ability to cope with a crisis or to return to pre-crisis status quickly) was assessed by the Chinese version of 10 item Connor-Davidson Resilience Scale (CD-RISC-10). It was modified from the original CD-RISC [37] to create a 10-item unidimensional scale [38]. Each item is rated from 4 (true nearly always) to 0 (not true at all). The total score ranges from 0 to 40, wherein a higher score reflects greater psychological resilience. The Cronbach's α of Chinese version of CD-RISC-10 is 0.88 [39]. In the present study, the Cronbach's α was 0.82.

Health-related quality of life

HRQoL was measured by the Short Form 12 Health Survey (SF-12), which includes 12 items reflecting the information

about physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH). Based on the weighted score for each item, both physical and mental score can be calculated. A higher score indicates better physical and mental HRQoL. The Chinese version of the SF-12 shows an acceptable reliability with Cronbach' α of 0.899 [40]. In the present study, the Cronbach's α was 0.872.

Statistical analysis

Data analysis was conducted by SPSS version 22.0 (IBM Corp, Armonk, New York). Means ± Standard Deviations (SDs) (after confirmation of normal distribution using the Kolmogorov–Smirnov test), frequency, and percentages were used to describe the characteristics of the patients. Independent t test and one-way analysis of variance (with the Bonferroni post hoc test) were used to examine the differences in HRQoL by sample characteristics. Pearson r coefficients were calculated to examine the bivariate correlations of HRQoL, symptoms status, self-management, and psychological resilience.

In the present study, the logic map was shown in Fig. 1, the moderation effects were explored using the PROCESS macro for SPSS (model 1 was chosen based on the logic map and "Model templates for PROCESS for SPSS and SAS"), which uses ordinary least squares regression [41]. Self-management and psychological resilience were set separately as moderators in the analysis. Unadjusted models and models adjusted for covariates (such as education level and co-morbidity status) were tested. To avoid multi-collinearity effects, three main variables (symptoms, self-management, and psychological resilience) were standardized in all models. Significance level and R^2 change due to interaction term were examined. Statistical significance level was set at 0.05. When hypothesized moderation effects were statistically significant, we performed the simple slope test by both pick-a-point method and the Johnson-Neyman method using the PROCESS macro. The pick-a-point method is the most popular approach to probing simple slope test. This procedure involves selecting a value or values of the moderator, calculating the conditional effect of X on Y at that value or values, and generating a confidence interval. The Johnson-Neyman method is essentially the pick-a-point approach conducted in reverse [42]. The results were interpreted by a comprehensive consideration of the two methods. To visually present the results, we obtained the graphic representations using the Jamovi software.

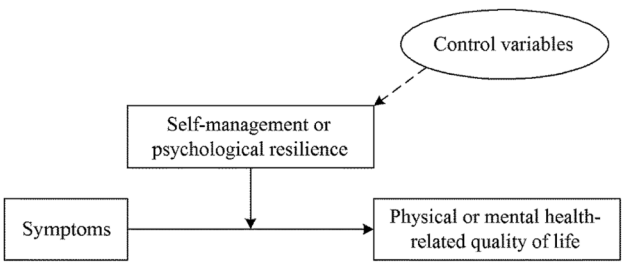

Fig. 1 The logic map of the moderation effects

The PROCESS macro is recommended by Hayes [41, 43] in this type of research, which has some unique advantages to examine the moderation effects. First of all, the PROCESS macro is more suitable than the structural equation method when the potential moderation variables in this study are continuous explicit variables. Second, the requirements for sample size and the type of data distribution for the PROCESS macro are relatively lower than those for linear regression and structural equation method. Third, Bootstrap method is used for interval estimation of coefficients through PROCESS macro, thus the results would be more accurate than linear regression. Fourth, the generalization achieved by this method is straightforward.

Results

Sample characteristics

Of 220 participants, 128 (58.2%) were female, 106 (48.2%) were > 60 years of age, 106 (48.2%) had a bachelor degree or higher, 62 (24.1%) were current smokers, 69 (31.4%) were inclined to drink alcohol in their daily life, 138 (62.7%) had a family history of cardiovascular diseases, and 133 (60.5%) had moderate to severe CCI (CCI ≥ 3). Detailed information about patients' demographic, clinical characteristics and comorbidity are presented in Table 1.

Mean scores and correlations between health-related quality of life and other variables

Comparisons of physical and mental HRQoL by the sample characteristics were presented in Table 2. The results indicated that patients' physical HRQoL was influenced by age, education level, employment status, blood pressure level (during physician's office visiting), and Charlson comorbidity index, while mental HRQoL was determined by education level and Charlson comorbidity index. As shown in Table 3, the mean score of self-management was 59.71 ± 13.22, indicating low level of self-management engagement among hypertensive patients with reference to the grading level. As for psychological resilience, the mean score was 24.45 ± 7.64. HRQoL for physical and mental scores presented with mean scores of 43.26 ± 11.16 and

Table 1 Demographic and clinical characteristics ($N = 220$)

Characteristics	N (%)
Age	
< 60 years old	114 (51.8)
≥ 60 years old	106 (48.2)
Gender	
Male	92 (41.8)
Female	128 (58.2)
BMI	
Normal	70 (31.8)
Overweight	95 (43.2)
Obesity	55 (25.0)
Marital status	
Married	198 (90.0)
Other	22 (10.0)
Income	
< 2000 RMB	80 (36.4)
≥ 2000 RMB	140 (63.6)
Education level	
Senior high school or lower	114 (51.8)
College or higher	106 (48.2)
Employment	
Employed	63 (28.6)
Unemployed	157 (71.4)
Smoking status	
Yes	62 (24.1)
No	158 (75.9)
Alcohol intake	
Yes	69 (31.4)
No	151 (68.6)
Family history of cardiovascular diseases	
Yes	138 (62.7)
No	82 (37.3)
Disease duration	
0–5 years	43 (19.5)
6–10 years	120 (54.5)
> 10 years	57 (25.9)
Classification of blood pressure level	
Normal high value	40 (18.2)
Grade 1 hypertension	105 (47.7)
Grade 2 hypertension	48 (21.8)
Grade 3 hypertension	27 (12.3)
Comorbidities	
Myocardial infarction	76 (34.5)
Congestive heart failure	14 (6.4)
Cerebrovascular disease	37 (16.8)
Peripheral vascular disease	155 (70.5)
Connective tissue disease	19 (8.6)
Peptic ulcer disease	9 (4.1)
Diabetes mellitus	74 (33.6)
Chronic kidney disease	12 (5.5)
Liver disease	5 (2.3)
Charlson comorbidity index	
Mild	87 (39.5)
Moderate to severe	133 (60.5)

Table 1 (continued)

HRQoL health-related quality of life, *SD* standard deviation, *BMI* body mass index, *RMB* renminbi

48.96 ± 10.19, respectively. Symptoms showed negative correlation to both physical ($r = -0.663$, $p < 0.001$) and mental HRQoL ($r = -0.795$, $p < 0.001$). Self-management and psychological resilience were positively correlated to physical ($r = 0.316$, $p < 0.001$; $r = 0.344$, $p < 0.001$) and mental HRQoL ($r = 0.273$, $p < 0.001$; $r = 0.309$, $p < 0.001$), but the association between self-management and psychological resilience was not statistically significant ($r = 0.131$, $p > 0.05$). In addition, self-management ($r = -0.259$, $p < 0.001$) and psychological resilience ($r = -0.282$, $p < 0.001$) had negative correlations to symptoms.

Moderation effects of self-management and psychological resilience

As shown in Table 4, self-management moderated the relationships between symptoms and physical HRQoL in the unadjusted model ($p = 0.023$, $\Delta R^2 = 0.013$) and the moderation effects remained significant after controlling for potential covariates ($p = 0.041$, $\Delta R^2 = 0.010$). The results of the Johnson-Neyman method demonstrated that there were no statistical significance transition points within the observed range of the moderator. The pick-a-point method (Table 5) indicated that the negative effects of symptoms on physical HRQoL were statistically significant under three different levels (low, participants scoring below -1.00 standard deviation; medium, participants scoring between -1.00 and $+1.00$ standard deviations; high, participants scoring above $+1.00$ standard deviation) of self-management but effects sizes were not homogenous. To sum up, conditional effects of symptoms on physical HRQoL were statistically significant across the entire range of self-management capability but were not constant. As presented in Fig. 2, the slope of the straight line reflects the conditional effects of symptoms on physical HRQoL under three different self-management levels (The steeper the line, the stronger the negative effects of symptoms on physical HRQoL). Therefore, negative effects of symptoms on physical HRQoL was weaker for hypertensive patients with higher level of self-management engagement but stronger for those with lower level of self-management. In summary, hypertensive patients with better self-management engagement were less likely to be affected by symptoms. Nevertheless, moderation effects of self-management on the relationships between symptoms and mental HRQoL was not statistically significant ($p = 0.26$, $\Delta R^2 = 0.002$).

Table 6 shows that psychological resilience moderated the relationships between symptoms and mental HRQoL in the unadjusted model ($p = 0.01$, $\Delta R^2 = 0.011$) and the

Table 2 Comparison of physical and mental health-related quality of life by the demographic and clinical characteristics ($N = 220$)

Characteristics	Physical HRQoL Mean ± SD	*p*	Mental HRQoL Mean ± SD	*p*
Age				
< 60 years old	45.33 ± 10.04	0.004**	49.67 ± 10.36	0.285
≥ 60 years old	41.03 ± 11.91		48.20 ± 10.00	
Gender				
Male	43.80 ± 11.08	0.545	49.49 ± 9.97	0.516
Female	42.87 ± 11.25		48.58 ± 10.37	
BMI				
Normal	44.14 ± 10.59	0.507	50.25 ± 10.00	0.416
Overweight	43.45 ± 11.52		48.59 ± 10.24	
Obesity	41.82 ± 11.30		47.97 ± 10.37	
Marital status				
Married	43.64 ± 11.03	0.125	49.97 ± 10.28	0.973
Other	39.80 ± 11.98		48.89 ± 9.54	
Income				
< 2000 RMB	43.35 ± 11.13	0.929	48.39 ± 9.94	0.526
≥ 2000 RMB	43.21 ± 11.22		49.29 ± 10.35	
Education level				
Senior high school or lower	40.71 ± 11.72	0.001**	47.15 ± 10.83	0.011*
College or higher	45.63 ± 10.11		50.65 ± 9.30	
Employment				
Employed	44.96 ± 10.26	0.153	49.96 ± 9.66	0.361
Unemployed	42.58 ± 11.47		48.57 ± 10.40	
Smoking status				
Yes	43.84 ± 11.43	0.629	49.33 ± 9.76	0.742
No	43.03 ± 11.08		48.82 ± 10.38	
Alcohol intake				
Yes	44.38 ± 10.48	0.315	49.15 ± 10.07	0.856
No	42.75 ± 11.46		48.88 ± 10.28	
Family history of cardiovascular diseases				
Yes	43.43 ± 11.24	0.776	49.37 ± 10.14	0.442
No	42.98 ± 11.09		48.28 ± 10.30	
Disease duration				
0–5 years	44.86 ± 10.73	0.030*	50.25 ± 9.75	0.113
6–10 years	42.91 ± 11.32		47.90 ± 11.59	
≥ 10 years	40.15 ± 11.45		47.06 ± 9.77	
Classification of blood pressure level				
Normal high value	47.34 ± 9.36	0.038*	51.58 ± 9.30	0.072
Grade 1 hypertension	42.49 ± 11.40		49.33 ± 10.24	
Grade 2 hypertension	40.87 ± 11.43		45.95 ± 10.09	
Grade 3 hypertension	44.46 ± 11.09		49.02 ± 10.65	
Charlson comorbidity index				
Mild	47.20 ± 8.87	< 0.001**	50.83 ± 9.54	0.028*
Moderate to severe	40.68 ± 11.77		47.73 ± 10.45	

HRQoL health-related quality of life, *SD* standard deviation, *BMI* body mass index, *RMB* renminbi
*$p < 0.05$; **$p < 0.01$

moderation effects remained significant after controlling for potential covariates ($p = 0.02$, $\Delta R^2 = 0.010$). The results of the Johnson-Neyman method demonstrated that there were no statistical significance transition points within the observed range of the moderator. The pick-a-point method (Table 7) indicated that the negative effects of symptoms on

Table 3 Mean scores and correlation coefficients of physical and mental health-related quality of life, symptoms, self-management, psychological resilience

Variable	Mean ± SD	1	2	3	4
1. Symptoms	21.36 ± 3.51				
2. Self-management	59.71 ± 13.22	−0.259**			
3. Psychological resilience	24.45 ± 7.64	−0.282**	0.131		
4. Physical HRQoL	43.26 ± 11.16	−0.663**	0.316**	0.344**	
5. Mental HRQoL	48.96 ± 10.19	−0.795**	0.273**	0.309**	0.628**

HRQoL health-related quality of life, *SD* standard deviation

*$p < 0.05$; **$p < 0.01$

Table 4 Unadjusted and adjusted models regressing symptoms, self-management and interaction of symptoms and self-management on physical health-related quality of life

Variables	B [95% CI]	*t*	*p*	ΔR^2
Unadjusted model				0.013
Symptoms	−6.53 [−7.13, −5.94]	−11.02	< 0.001**	
Self-management	1.67 [1.67, 2.24]	2.94	0.004**	
Symptoms × self-management	1.22 [0.69, 1.76]	1.22	0.023*	
Adjusted model				0.010
Age	−1.37 [−3.61, 0.86]	−1.21	0.226	
Education level	1.29 [−0.89, 3.48]	1.17	0.244	
Disease duration	−1.24 [−2.51, −0.03]	−2.08	0.039*	
Classification of blood pressure level	−0.50 [−1.70, 0.70]	−0.82	0.414	
Charlson comorbidity index	−2.72 [−5.09, −0.35]	−2.26	0.025*	
Symptoms	−5.80 [−6.39, −5.21]	−9.84	< 0.001**	
Self-management	1.30 [1.85, 0.75]	2.36	0.019*	
Psychological resilience	1.51 [0.41, 2.62]	2.71	0.007*	
Symptoms × self-management	1.06 [0.54, 1.57]	2.06	0.041*	

Unadjusted model: $p < 0.001$, $R^2 = 0.47$

Adjusted model: $p < 0.001$, $R^2 = 0.54$, adjusted for age, education level, diseases duration, classification of blood pressure level and Charlson comorbidity index as well as psychological resilience

ΔR^2: R^2 change due to interaction term

CI confidence interval

*$p < 0.05$; ** $p < 0.01$

Table 5 Moderation effects of self-management on the relationships between symptoms and physical health-related quality of life

Value of self-management	Effect [95% CI]	*t*	*p*
Mean − 1 × SD	−6.85 [−7.53, −6.17]	−10.09	< 0.001**
Mean	−5.79 [−6.38, −5.20]	−9.82	< 0.001**
Mean + 1 × SD	−4.74 [−5.61, −3.86]	−5.42	< 0.001**

SD standard deviation, *CI* confidence interval

*$p < 0.05$; **$p < 0.01$

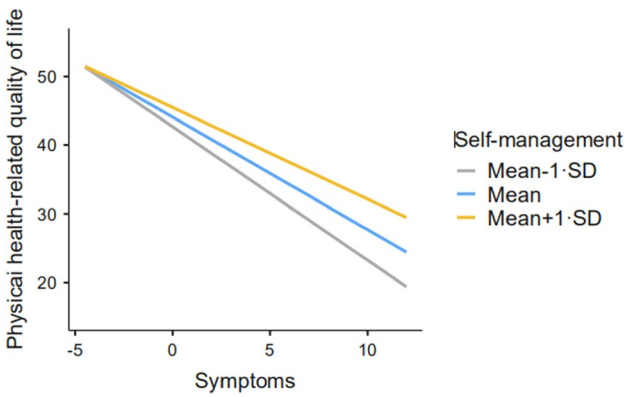

Fig. 2 Moderation effects of self-management on symptoms and physical health-related quality of life

mental HRQoL were statistically significant under three different levels (low, participants scoring below − 1.00 standard deviation; medium, participants scoring between − 1.00 and + 1.00 standard deviations; high, participants scoring above + 1.00 standard deviation) of psychological resilience effects sizes were not homogenous. That means that conditional

Table 6 Unadjusted and adjusted models regressing symptoms, psychological resilience and interaction of symptoms and psychological resilience on mental health-related quality of life

Variables	*B* [95% CI]	*t*	*p*	ΔR^2
Unadjusted model				0.011
Symptoms	−7.64 [−7.21, −8.07]	−17.75	< 0.001**	
Psychological resilience	0.97 [0.54, 1.39]	2.27	0.02*	
Symptoms × psychological resilience	1.20 [0.73, 1.67]	2.56	0.01*	
Adjusted model				0.010
Education level	0.53 [−1.17, 2.22]	0.61	0.54	
Charlson comorbidity index	−0.37 [−1.26, −0.33]	−2.32	0.02*	
Symptoms	−7.47 [−7.02, −7.92]	−16.60	< 0.001**	
Self-management	0.92 [0.07, 1.78]	2.13	0.03*	
Psychological resilience	0.94 [0.51, 1.37]	2.18	0.03*	
Symptoms × psychological resilience	1.12 [0.64, 1.59]	2.35	0.02*	

Unadjusted model: $p < 0.001$, $R^2 = 0.45$

Adjusted model: $p < 0.001$, $R^2 = 0.50$, adjusted for education level, Charlson comorbidity index and self-management

CI confidence interval

ΔR^2: R^2 change due to interaction term

*$p < 0.05$; **$p < 0.01$

Table 7 Moderation effects of psychological resilience on the relationships between symptoms and mental health-related quality of life

Value of psychological resilience	Effect [95% CI]	*t*	*p*
Mean − 1 × SD	−8.58 [−9.19, −7.96]	−13.95	< 0.001**
Mean	−7.46 [−7.91, −7.01]	−16.57	< 0.001**
Mean + 1 × SD	−6.34 [−7.03, −5.65]	−9.15	< 0.001**

SD standard deviation, *CI* confidence interval

*$p < 0.05$, **$p < 0.01$

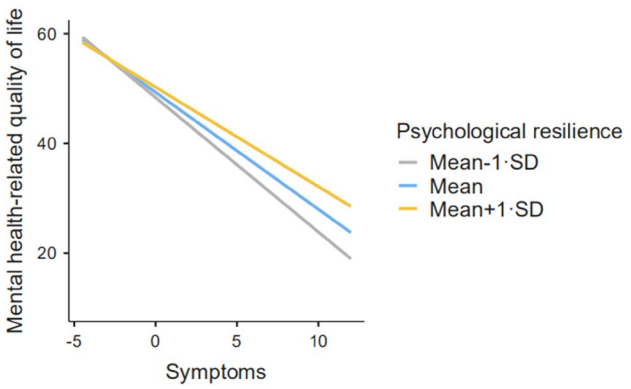

Fig. 3 Moderation effects of psychological resilience on symptoms and mental health-related quality of life

effects of symptoms on mental HRQoL were statistically significant across the entire range of psychological resilience but were not constant. As presented in Fig. 3, the slope of the straight line reflects the conditional effects of symptoms on mental HRQoL under three different psychological resilience levels (the steeper the line, the stronger the negative effects of symptoms on mental HRQoL). Therefore, the negative tendency was weaker for hypertensive patients with higher level of psychological resilience but stronger for those with lower level of psychological resilience. In detail, among hypertensive patients with better psychological resilience, negative effects of symptoms on mental HRQoL could be weakened. Nevertheless, the moderation effects of psychological resilience on the relationships between symptoms and physical HRQoL were not statistically significant ($p = 0.08$, $\Delta R^2 = 0.006$).

Discussion

To the best of our knowledge, this was the first study to examine the moderation effects of self-management and psychological resilience on the association between symptoms and HRQoL among hypertensive patients. These findings provide new insights to optimize patients' HRQoL by considering the complicated relationships among symptoms, self-management, psychological resilience, and physical and mental HRQoL.

In the present study, patients' self-management engagement was negatively correlated to their symptoms status. The results might be partially attributed to long disease duration and severe co-morbidity status of our samples. Engagement in self-management might delay the progression of hypertension and result in fewer symptoms [21, 44]. Besides, symptoms caused by hypertension and subsequent complications could add complexity to patients' health care regimens,

which might lead to poor engagement of self-management [45–47]. Advancing the understanding of self-management, symptoms, and HRQOL, the research demonstrated that better self-management could weaken the negative effects of symptoms on physical HRQoL. One possible explanation was that hypertensive patients with better self-management also had positive illness beliefs. Thus they could interpret correctly and cope rationally with hypertension-attributed symptoms relying on their better understanding of the diseases [48]. Another explanation might be that better self-management could offer hypertensive patients with sufficient support from healthcare teams and social circles [49, 50]. And they could obtain additional information or feedback enhancing their HRQoL. Unfortunately, the moderation effects of self-management on associations between symptoms and mental HRQoL were not evident. This reflected the fact that self-management education programs in China focused more on preventive measures to deal with patients' potential physical problems but included less practical guideline to relieve patients' mental distresses [51]. In the future, Chinese health care providers should pay close attention to psychological issues of patients. In addition, symptoms management of patients with poor self-management capability should be emphasized, because the negative effects of symptoms on physical HRQoL was more obvious in this category of patients. It could improve patient's HRQoL by achieving better patient's self-management levels and reducing the adverse impact of symptom on HRQoL.

The present study revealed that psychological resilience was negatively correlated to symptoms. Indeed, psychological resilience could buffer the negative effects of depression and maintain physical or emotional health [52]. Manning [53] reported that patients' higher level of resilience could relieve to a large extend the deleterious consequences related to the onset of chronic diseases and subsequent disability. In accordance with previous studies, our study further demonstrated that the better the psychological resilience, the less symptoms affect mental HRQoL. As Joslyn S. Kirby [54] reported, patients with higher psychological resilience could experience a smaller decrease in HRQoL when they suffered from increased depressive symptoms. Psychological resilience was proved to be positively correlated to problem-oriented rather than emotion-oriented coping style [55]. Therefore, hypertensive patients with higher level of resilience tended to adopt more effective and reasonable ways to manage symptoms and further relieved their negative effects on mental HRQoL. Although not evident, there was still a trend indicating moderation effects of psychological resilience on the association between symptoms and physical HRQoL. Given the less evidence on psychological resilience, further investigation is warranted. In the clinical management of patients, psychological resilience was regarded as the nursing evaluation standard of patients. It also highlights that patients with poor psychological resilience should receive special attention.

Some limitations in our study should be taken into consideration when interpreting the results. Firstly, this was a cross-sectional study with no ability to infer causality, and a longitudinal or experimental study is warranted. Second, the participants were considered to be representative of hypertensive patients who lived in Tianjin, China. Hence, future studies with more participants from different regions in China, and ultimately in other countries, are warranted, as well as studies in community. Third, many patients had complicated co-morbidity in this research. Although we used Charlson Comorbidity Index to control the potential bias caused by other diseases, there still might be some bias. In addition, the assessments were based on participants' self-reporting, which might be subject to information bias.

Conclusions

In light of the pivotal effects of symptoms to predict HRQoL among hypertensive patients, a plausible criteria to improve their HRQoL is to find modifiable factors that may influence the strength and direction of the relationship between symptoms and HRQoL. Guided by the W–C model, the present study strongly suggests that self-management and psychological resilience could moderate the relationships between symptoms and HRQoL. This indicates that further intervention to improve patients' HRQoL would be optimized by considering the complicated relationships between self-management, psychological resilience, and their symptoms.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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