The effect of self-management on the health-related quality of life in hypertensive patients in Xiamen, China

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Abstract

Background: A low HRQOL can be a risk factor for future cardiovascular events in patients with hypertension. Therefore, HRQOL should receive attention and be improved in the treatment of hypertension. The purpose of this study was to investigate if the association between treatment groups and Health-Related Quality of Life (HRQOL) of hypertension mediated by self-management, and to determine which factors of hypertension self-management influenced HRQOL.

Methods: Hypertensive patients were selected by multi-stage stratified samping from “1+1+N” Physicians intervention (PI) group and the conventional management (CM) group in 5 communities of Xiamen, China. Patients were cross-sectionally assessed by validated self-reports using self-management Behavior Rating Scale and Quality of Life Instruments for Hypertension. A structural equation modeling (SEM) and a path analytic model were used to assess if the association between treatment groups and HRQOL was mediated by self-management.

Results: A total of 1207 patients were included, of whom 48.55% were in the PI group. The average score of the HRQOL scale was 86.68, and the average score of the PI group was higher than the CM group (87.35 vs 86.04, respectively). Similar findings were observed for the self-management scale, in which the average score of the PI group was higher than the CM group (76.32 vs 72.00, respectively). Patients in the PI group had higher levels of self-management compared to the CM group except for management of emotion. SEM showed that the association between treatment groups and HRQOL was significantly mediated by self-management (a*b, 95% confidence intervals CI: 0.02,0.07) and that the single mediator (self-management) model explained 76.67% of the intervention effect. In the multivariable mediation model, the association between treatment groups and HRQOL was significantly mediated by management of medication adherence, sport and diet.

Conclusions: The findings presented good evidence supporting that treatment groups are linked to HRQOL of hypertension via self-management. Specifically, management of medication adherence, sport, diet, and emotion are important for improving HRQOL.

Background

Due to its high prevalence and mortality rate, hypertension is a serious public health issue worldwide. According to a report by the National Association of Blood Pressure, 54% of strokes, 47% of ischemic heart diseases, and 25% of other cardiovascular disease are caused by hypertension. [1] Hypertension is the main cause of disability and is considered the most important risk factor for mortality globally. Annually, it causes approximately 71 million deaths worldwide; the mortality rate was 26.4% in the year 2000, and is expected to rise to 29.2% by 2025. [2] The Report on Cardiovascular Diseases in China indicated that one in five Chinese individuals suffered from hypertension, accounting for approximately 24.6% of all deaths in the year 2015. [3] The Analysis Report of National Health Services Survey in China (2013) reported that the prevalence of hypertension was 14.2%. Moreover, the health report in Xiamen

(2014) reported that the prevalence of hypertension was 18.21%. Overall, hypertension has become one of the major public health issues in China. [4]

Previous studies have indicated that hypertension seriously affected a patients' health and had an adverse effect on a patients' well-being and health-related quality of life (HRQOL). [5] The complex nature of the disease and the feeling of not being well will diminish the quality of life and result in decreased satisfaction with daily life in patients with hypertension. [6] To achieve a better therapeutic effect, HRQOL has been recognized in both the clinical and community health research as an important health outcome, and a required supplement to conventional health outcomes. HRQOL is an assessment of health status that is based on the modern concept of healthcare, considers not only the physical, but also the psychosocial and social impact of an illness, and is an important health indicator in medical interventions and health surveys. [7–9] A low HRQOL can be a risk factor for future cardiovascular events in patients with hypertension. Therefore, HRQOL should receive attention and be improved in the treatment of hypertension.

The main influencing factors of HRQOL include age, education level, complications, and living habits, among which self-management is an important aspect. Previous studies have reported that self-management was a beneficial adjunct team-based care for improving HRQOL. [10, 11] In our study, we aimed to enhance the ability of self-management to ultimately improve HRQOL through several measures, including home blood pressure (BP) telemonitoring and pharmacist management. [12] In Xiamen, China, a unique multi-tiered medical care system was introduced in 2015,which is an innovative exploration of medical reform in this city.[13] The unique multi-tiered medical care system of "1 + 1 + N" Physicians management was applied in the management of chronic diseases by local government. By the end of June, 2016, the project of "1 + 1 + N" Physicians management had been implemented in 38 communities of Xiamen and 19.9 thousand patients were involved. Based on the project, community-dwelling patients were divided into "1 + 1 + N" Physicians intervention group (PI) and conventional management group (CM). More specifically, patients who signed for "1 + 1 + N" Physicians management project would receive health care services from one top specialist from major hospitals, one general practitioners and some community nurses. System top specialists from major hospitals were encouraged to work at community health and medical centers for certain hours every week to see patients and provided guidance to general practitioners. In addition, general practitioners were encouraged to sign a service contract with community residents. Community nurses provided services, such as health education for their communities on prevention and control of chronic diseases so that patients could better manage their own health. Moreover, the other patients who not signed for "1 + 1 + N" Phycian management project received conventional management (CM) would work with their general practitioner or nurses on taking routine BP measurement and adjusting medication at the discretion of health professionals. Compared with the CM group, the PI group was different in their following up approach. The frequency of follow-up with top specialists, general practitioners, and community nurses was for twice a month, once a month, and once every two weeks, respectively. Moreover, styles of management were different. The PI group received regular health education and one-on-one guidance to set individualized management. Finally, the PI group received free medical examination twice a year.

Studies that focused on the relation of self-management between the treatment groups and HRQOL are limited. Previously, it was demonstrated that increased frequency of self-management in home BP monitoring, and interactions with pharmacists and lifestyle modification were mediators of improved BP control. [14, 15] Margolis et al. found that increased monitoring and medication intensification were major mediators of the intervention effect. [16] In our study, we focused on exploring whether self-management contributed to HRQOL as a key mediator in the treatment groups. Furthermore, we analyzed different components of self-management, since ineffective components can be deemphasized to direct more resources toward effective components. Therefore, we conducted a mediation analysis to determine the factors of self-management that were the major contributors of HRQOL improvement observed in the trial. Suggestions are provided for intervention and strategies to improve HRQOL by self-management.

Methods

Study population and design

After the policy of “1 + 1 + N” Physicians management had been implemented for one year, we performed a cross-sectional survey among local adults with hypertension in Xiamen, China, in 2016. Sample size was calculated by the Krejcie and Morgan formula: [17]

$$N = u_{\alpha/2}^2 \; P \; (1 - P)/d^2 \quad (1)$$

in which $U_{\alpha/2}$=1.96 when α = 0.05, P represented the prevalence rate of hypertention (which was 14.2% in this study), and d was the admissible error (which was 0.15P). In the survey, the theoretical sample size was 1290 as determined by a multistage stratified sampling procedure, which included an extra 20% to allow for lost of participates during the investigation. 645 patients with hypertension were randomly selected from the PI group and the CM group in 5 communities, respectively. Eligibility criteria were: (a) aged 20 years or older; (b) willing to participate in the survey; (c) lacal household-registered and living in communities for most of the time; (d) diagnosed as hypertension according to *2010 Chinese Guidelines for Prevention and Treatment of Hypertension*; (e) patients from PI group had received intervention for a year since July, 2015; (f) patients from CM group had never received “1 + 1 + N” Phycisians intervention.

Ethics Statement

This study was approved by the ethical review committee of the School of Public Health, Xiamen University (Xiamen, China). Written informed consent was obtained for each patient and questionnaires were completed by face-to-face interview. Interviewers read the questions exactly as they appeared on the questionnaire. Options were verbally provided by the patients and the corresponding codes were then filled in the questionnaires by the interviewers. A total of 1207 questionnaires were recovered, with a response rate of 93.57%.

Sociodemographics

In the present study, demographic characteristics included age, gender, body mass index (BMI), locality, duration of hypertension, family history, and referral experience. Early life health behavior included smoking history, drinking history, and amount of sleep.

Measures Of Health-related Quality Of Life And Self-management

To investigate the association between self-management with the HRQOL of hypertensive patients, Quality of Life Instruments for Chronic Diseases of Hypertension(QLICD-HY) and self-management Behavior Rating Scale were developed by ourselves based on literature reviews and nominal/focus group discussions. Cronbach's coefficient for QLICD-HY and the self-management scale were 0.972 and 0.937 respectively, indicating adequate reliability and validity. They were reliable and appropriate in this study.

HRQOL was used as the health outcome and was measured by QLICD-HY. [18] QLICD-HY was created by combining the general module (QLICD-GM) and the specific module for hypertension. The QLICD-GM included 32 items, consisting of three domains: physical function (e.g. mobility, sensory, appetite, sleep, and energy), psychological function (e.g. emotion, cognition, and stress), and social function (e.g. social support and adaptation, work, family). Meanwhile the specific module included 17 items reflecting the symptoms, side effects and mental health conditions specific to hypertension.

Self-management was established by the hypertension patients self-management Behavior Rating Scale. The scale consists of 33 items assessing behaviors related to medication adherence, monitoring, sport, dietary, and emotional management. Each item was scored on a 5-point Likert scale where the respondents could choose from one of five responses ranging from 'strongly disagree' to 'strongly agree'. Domain scores were converted using the following formula for comparison: SS=(Rs-Min)*100/R, where SS, Rs, Min, and R represented standardized score, raw score, minimum score of the dimension, and range of scores in the domain, respectively. The higher the HRQOL/self-management score, the higher the quality of life/self-management level.

Statistical analysis

The database used was established using EpiData Version 3.1 (The EpiData Association, Odense, Denmark). All questionnaires were coded and double-entered by two independent professional data-entry staff members. SAS software version 9.4 for Windows (SAS Institute, Inc., Cary, NC, USA) was used to compute the descriptive analysis of patient demographics and disease-related information.

First, descriptive statistics were calculated for basic demographic variables, the mean and standard deviation (SD) were calculated for continuous variables, and frequencies and percentages were

calculated for categorical variables. Chi-square tests and Kruskal–Wallis tests were used to test the significance among variables. P values less than 0.05 were considered significant.

Second, analyses were performed using SPSS version 22.0 software including AMOS 20.0 (IBM Corp, Chicago, IL, USA). Structural equation modeling (SEM) was performed using maximum likelihood estimation to test single-mediator models, in which the relation between the treatment groups and HRQOL was mediated through self-management. Boxes indicated manifest measurement variables, ovals indicated latent variables operationalised by manifest indicators (Fig. 1(A)). A binary indicator for the study treatment groups predicted a potential mediator self-management (path a) and the mediator self-management predicted HRQOL (path b). The model allowed for obtaining regression coefficients and the product of paths (ab) represented the specific indirect effect for a mediator, which was referred to as the mediated effect. The study treatment groups indicator predicted that a HRQOL that was not explained by the mediated path ab as path c'. The total unmediated effect of the intervention was path c (Fig. 1(B)), when no mediators were included in the model), which, in this case represented the between-group differences in HRQOL. The proportion of the total effect of the intervention due to mediating effects was computed as (c-c')/c. [19, 20] To enable the analysis of hypertension self-management and HRQOL as a composite measure, modelling was performed as latent variable operationalized by the Hypertension Patients Self-management Behavior Rating Scale and QLICD-HY, and included self-management with five observed variables: management of medication adherence, monitoring management, sport management, diet management and emotional management, and HRQOL with four variables: physical function, psychological function, social function and the specific module for hypertension. Ovals represented latent factors, whereas rectangles represented observed variables. Moreover, arrows represented path coefficients for regression of an observed variable onto a latent factor or of one factor onto another. Various fit indexes associated with the SEM technique were assessed and included chi-square, goodness of fit index (GFI), comparative fit index (CFI), increasing fit index (IFI), normed fit index (NFI), and root mean square error of approximation (RMSEA). [21–23]

Third, path analytic models [24, 25] were used to assess multiple-mediator models, in which all five potential mediators were utilized, each with a path from the study treatment groups variable to the mediator (paths a1-5, Fig. 2(A)), and from the mediator-predicted HRQOL (paths b1-5). [26] The total unmediated effect of the treatment was path c (Fig. 2(B)).

Mediation by a specific variables was deemed significant when zero was not included as a specific indirect effect (ab) of 95% CI. [27] To account for potential confounding factors by socio-demographic variables, tested models were adjusted for BMI, family history, duration of hypertention, and life styles by modelling associations between these covariates and the three main variables. [10, 28]

Results

Demographic Characteristics

The analytic sample consisted of 1207 patients who completed the study. The demographic characteristics of the study are presented in Table 1, which shows that the treatment groups were closely matched with respect to demographic characteristics. A total of 58.8% of patients was older than 65 years of age and with a rate of 46.1% of the patients being male, the gender distribution was relatively balanced. Approximately 37.4% of patients had an educational level of high school or above. In addition, more than 80% of patients had a duration of hypertension of less than 20 years. Of the 1207 hypertensive patients, 586 patients were enrolled in the PI group, whereas 621 patients were placed in the CM group. A total of 313 (53.4%) patients in the PI group and 338 (54.4%) patients in the CM group were female, and 218 (37.2%) patients in the PI group and 233 (37.5%) patients in the CM group had senior level high school or higher. A duration of hypertension of less than 20 years was observed in 490 (83.6%) of patients in the PI group and 527 (84.9%) of patients in the CM group. The initial mean systolic BP (SBP) of patients when they joined the study was 161.0 mmHg in the PI group, and 160.5 mmHg in the CM group, whereas the initial mean diastolic BP (DBP) in the PI group was 95.0 mmHg and that of the CM group was 94.3 mmHg. The above variables did not differ between PI and CM group ($p > 0.05$). The average score of the self-management scale of the PI group was higher compared to that in the CM group (76.3 vs 72.0), and specifically included medical management, monitoring management, sport management, and diet management ($p < 0.05$). In addition, the average score of the HRQOL scale in the PI group was higher compared to that in the CM group (87.4 vs 86.0).

Table 1
Patient characteristics and proposed mediators.

Variables	All patients	PI[a] (n = 586)	CM[b] (n = 621)	*p*
Age (years), n (%)				
< 65	497	255(43.5)	242(39.0)	0.11
≥ 65	710	331(56.5)	379(61.0)	
Gender, n(%)				
Male	556	273(46.6)	283(45.6)	0.72
Female	651	313(53.4)	338(54.4)	
Education, n(%)				
Primary school and below	432	199(34.0)	233(37.5)	0.52
Junior high school	324	169(28.8)	155(25.0)	
Senior high school and above	451	218(37.2)	233(37.5)	
Marriage, n(%)				
Unmarried	6	3(0.5)	3(0.5)	0.94
Married	1201	583(99.5)	618(99.5)	
MLO[c], n(%)				
Jobless	238	106(18.1)	132(21.3)	0.08
Employed	815	414(70.7)	401(64.6)	
Farmer	154	66(11.3)	88(14.2)	
Duration of hypertention (years)				
< 20	1017	490(83.6)	527(84.9)	0.55
≥ 20	190	96(16.4)	94(15.1)	
BMI[d] (kg/m2), mean ± SD	24.8 ± 3.3	24.9 ± 3.3	24.6 ± 3.3	0.22
Initial blood pressure (mmHg), mean ± SD				
Systolic blood pressure	160.9 ± 18.5	161.0 ± 18.1	160.5 ± 17.5	0.66

*$p < 0.05$; **$p < 0.01$; [a] PI: "1 + 1 + N" Physicians Intervention; [b] CM: Conventional management; [c] MLO: main lifetime occupation; [d] BMI: body mass index.

Variables	All patients	PI[a] (n = 586)	CM[b] (n = 621)	*p*
Diastolic blood pressure	94.5 ± 15.4	95.0 ± 15.1	94.3 ± 15.4	0.43
Self-management, mean ± SD				
Medication adherence	88.1 ± 21.6	91.4 ± 16.2	84.9 ± 25.4	< 0.01**
Monitoring management	60.7 ± 24.8	63.6 ± 23.1	57.9 ± 26.0	< 0.01**
Sport management	74.1 ± 23.9	77.2 ± 21.8	71.2 ± 25.3	< 0.01**
Dietary management	73.9 ± 21.4	75.7 ± 20.5	72.2 ± 22.2	0.01*
Emotion management	74.6 ± 24.6	75.4 ± 24.3	73.8 ± 24.8	0.26

*$p < 0.05$; **$p < 0.01$; [a] PI: "1 + 1 + N" Physicians Intervention; [b] CM: Conventional management; [c] MLO: main lifetime occupation; [d] BMI: body mass index.

Single Mediator Models

The model presented in Fig. 3 was evaluated as a latent-variable structural model with two latent factors and was found to constitute good fit for the data: GFI = 0.96 > 0.90, CFI = 0.93 > 0.90, TLI = 0.92 > 0.90, IFI = 0.93 > 0.90, NFI = 0.91 > 0.90, RMSEA = 0.05 ≤ 0.06. The variable hypertension self-management was significantly operationalized by the self-management behaviors assessed (all path coefficients $p < 0.05$). Based on the related path coefficients (i.e. standardized regression coefficients), the most relevant behaviors included physical activity, dietary control, and emotional control.

The intervention group was indirectly linked to HRQOL (i.e. higher HRQOL) via higher self-management, and the bootstrapping test confirmed that this association was significant ($p < 0.01$). Again, the intervention group showed to be associated with a 0.14-unit increase regarding self-management classes, explaining the 2% variation in self-management. Each unit increase in self-management classes was associated with a 0.33-unit increase regarding the HRQOL, explaining the 13% of variation in HRQOL (both $p < 0.001$). The revealed mediated effect (a·b) of the intervention through self-management indicated that the intervention group was associated with an increase in HRQOL by 0.05 SD, and that the revealed mediated effect intensification accounted for 76.67% of the total effect of the intervention on changes in the HRQOL.

Multiple Mediator Model

The sorted values derived from the analysis of the multiple mediator model (Fig. 2), are presented in Table 2. The data show that the intervention group was associated with a 5.94-unit increase in the medication adherence management classes variable. Each unit increase in the medication adherence

management classes variable was associated with a 0.07-unit increase in the HRQOL count (both $p < 0.001$). Moreover, the mediated effect (a·b) of the intervention increased the HRQOL by 0.40 points by increasing the medication adherence management classes ($p < 0.05$). Similarly, the mediated effect of the intervention increased the HRQOL by 0.32 points by increasing sport management classes ($p < 0.05$). In addition, the mediated effect of the intervention increased the HRQOL by 0.27 points by increasing diet management classes ($p < 0.01$). Monitoring management and emotional management did not have a significant effect on the HRQOL.

Table 2
Coefficients and specific indirect effects in path models predicting differences in HRQOL from intervention and proposed mediating variables.

	Intervention effect on mediator Path a	**Mediator effect on HRQOL Path b**	**Mediator effect in HRQOL a*b (Bootstrap 95% CI)**	**Proportion of total effect due to mediated effect (c-c')/c (%)**
Multiple-mediator models[c]				
Medication adherence	5.94***	0.07***	0.40(0.18,0.74)	24.54
Sport management	5.80***	0.05**	0.32(0.10,0.70)	19.63
Diet management	3.26**	0.08***	0.27(0.07,0.58)	16.56
Monitoring management	4.38**	-0.01	-0.05(-0.24,0.09)	3.07
Emotional management	1.40	0.06**	0.08(-0.07,0.30)	4.91

[c]Multiple-mediator models adjusted for body mass index, family history, duration of hypertention, and life styles;

CI: confidence interval. **$p < 0.01$; ***$p < 0.001$.

Discussion

This study provides evidence that the intervention measure of “1 + 1 + N” Physicians indirectly affected HRQOL through self-management of hypertension. Self-management was a significant mediator and accounted for nearly all (76.67%) of the intervention effect as investigated by the potential mediators.

Our findings correlated with the data reported by Karen et al. in regarding the mediation effects of another pharmacist-led intervention to improve the health outcome of hypertension. The Karen et al. study showed that increased behavior of self-management was a mediator of improved BP control observed in the intervention group. [14, 16, 29, 30] Taken together, self-management was a key component of the

management of hypertension to improve HRQOL. In the present study, the CM group received regular care from a primary care clinician, whereas the PI group received “1 + 1 + N” Physicians supervision and showed an increase in self-management behavior when compared to the CM group, including medication adherence management, sport management, diet management, and monitoring management. Possible explanations for the effects seen on self-management in the PI group may include: (1) Patients received tailored individual counselling and a higher frequency of follow-up and were asked to adhere to the management of lifestyle modifications including diet, physical activity, taking medication, and monitoring illness by telephone or clinic treatment. Frequent follow-up help people cultivate self-management of healthy habits so as to help avoid deterioration of hypertension. [31, 32] (2) Positive communication between physicians and patients may improve a patient’s understanding and recall of information about the disease. Communication between providers and patients may play a more important role in building knowledge, belief about treatment, and confidence in the management of their hypertension. [33] (3) Increased health education by community nurses help a patient build up confidence, and recognize barriers to improve physical and psychological problems. Several reports have shown that education can lead to changes in a patients’attitude towards therapy and improve behavior. [34–36] Therefore, in the clinic, physicians can help improve health management by education and follow up and mitigate adverse health effects of poor self-management to help hypertensive patients get a better HRQOL.

In this study, we observed that improve medication adherence management, diet management, and sport management were significant mediators and had a significant effect on the HRQOL when compared to monitoring and emotional management in the multiple mediator model.

Improving management of medication adherence was key for behavioral intervention. In several studies, it was demonstrated that medication adherence management was a fundamental component to improve the HRQOL. [35, 37, 38] Despite the fact that previous studies highlighted the negative effects of antihypertensive medication on the HRQOL, adherence to antihypertensive treatment [39, 40] affected people from hypertensive complications, thereby improving therapeutic efficacy and enhancing social psychological function, which guaranteed an increased life expectancy and improvement in general well-being. Through health education, physicians may help patients master the basics of medication and make them aware of the necessity and side effects of drugs. It is an important way to maximize patients’s positive beliefs and improve medication adherence, and thereby helped to control hypertension and improve HRQOL. [41]

Lifestyle changes was another key target as it was estimated that diet and weight loss can be at least as effective as a single drug therapy in reducing BP. [42, 43]On the one hand, a number of studies showed that diet management, including reduced sodium intake, increasing the consumption of fruits, vegetables,low-fat diary products, and decreasing the consumption of saturated fat related to BP control[44]. On the other hand, sport management, including the time and frequency of exercise, such as jogging, Tai Chi, and square dance had a significant effect on HRQOL.We observed that regular exercise resulted in a comfortable mood and good health status. Smith and McFall reported that self-management of their exercise to control weight and improve body immunity were associated with

significant changes in the HRQOL, which may be due to the large reduction in impaired days for individuals who exercise. [45] Both exercise training and weight loss have been shown to decrease left ventricular mass and wall thickness, to reduce arterial stiffness, and to improve endothelial function. [46] Zhang et al. agreed that for patients with hypertension, regular exercise was important for improving the HRQOL. [10]

The findings of our study also indicated that we should focus on emotional management, which significantly improved the HRQOL. Prior studies demonstrated that factors of emotion, such as anxiety, anger, worry, depression, and overall emotional reactions were associated with an impaired HRQOL. [47] Emotional regulation helped hypertensive build up resilience to cope with stressful life events, improved health outcomes, and reduced disease incidences that were associated with psychological distress and quality of life. [48, 49] These results provided evidence that emotional management was a benefit for the HRQOL. Therefore, physicians should pay more attention to the importance of emotional health, which would need regular screening by standardized, validated questionnaires to identify patients who need appropriate psychotherapeutic or drug therapy. [50, 51]From the above, in order to achieve a better HRQOL, patients should not only improve their management of medication adherence, diet and emotion but also increase the frequency of physical activities.

Although promising, our results also show several limitations: First, the data were cross-sectional; hence, the study does not warrant causal implications. We used the SEM technique to show that the relationships between variables were tentative and require further validation. Second, the data of this study were collected using a self-reported questionnaire. Participants may underestimate or overestimate their self-management behaviors, which may have affected the results. Third, the participants were drawn from one state; therefore, our conclusions cannot be generalized to the entire country.

Conclusions

In summary, our findings demonstrated that more than half of the intervention effect in this multifaceted trial to improve HRQOL was attributed to self-management, particularly in medication adherence management, sport management, and diet management. This reinforces the importance of combining these three factors in improving impaired HRQOL.Besides, emotional management is also largely associated with the improvement of HRQOL, so hypertensive patients should pay attention to it. Moreover, the unique multi-tiered medical care system of “1 + 1 + N” Physicians management can be applied in other fields. These findings are beneficial in the design of future interventions in clinical practice, where improvement of HRQOL via self-management is important.

Abbreviations

HRQOL: health-related quality of life; PI: physicians intervention; CM: conventional management; SEM: a structural equation modeling; BMI: body mass index; QLICD-HY:quality of life instruments for chronic diseases of hypertension; QLICD-GM: quality of life instruments for general module; SD: standard

deviation; GFI: goodness of fit index; CFI: comparative fit index; IFI: increasing fit index; NFI :normed fit index ; RMSEA: root mean square error of approximation;SBP: systolic blood pressure; DPB:diastolic blood pressure; MLO: main lifetime occupation.

Declarations

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Authors's contributions

YF conceived and designed the study, supervised the data analysis; YZ, CL and FC wrote the paper; YZ performed all statistical analyses and CL contributed to revising the paper. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used in this study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the ethical review committee of the School of Public Health, Xiamen University (Xiamen, China). Written informed consent was obtained for each patient and questionnaires were completed by face-to-face interview.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

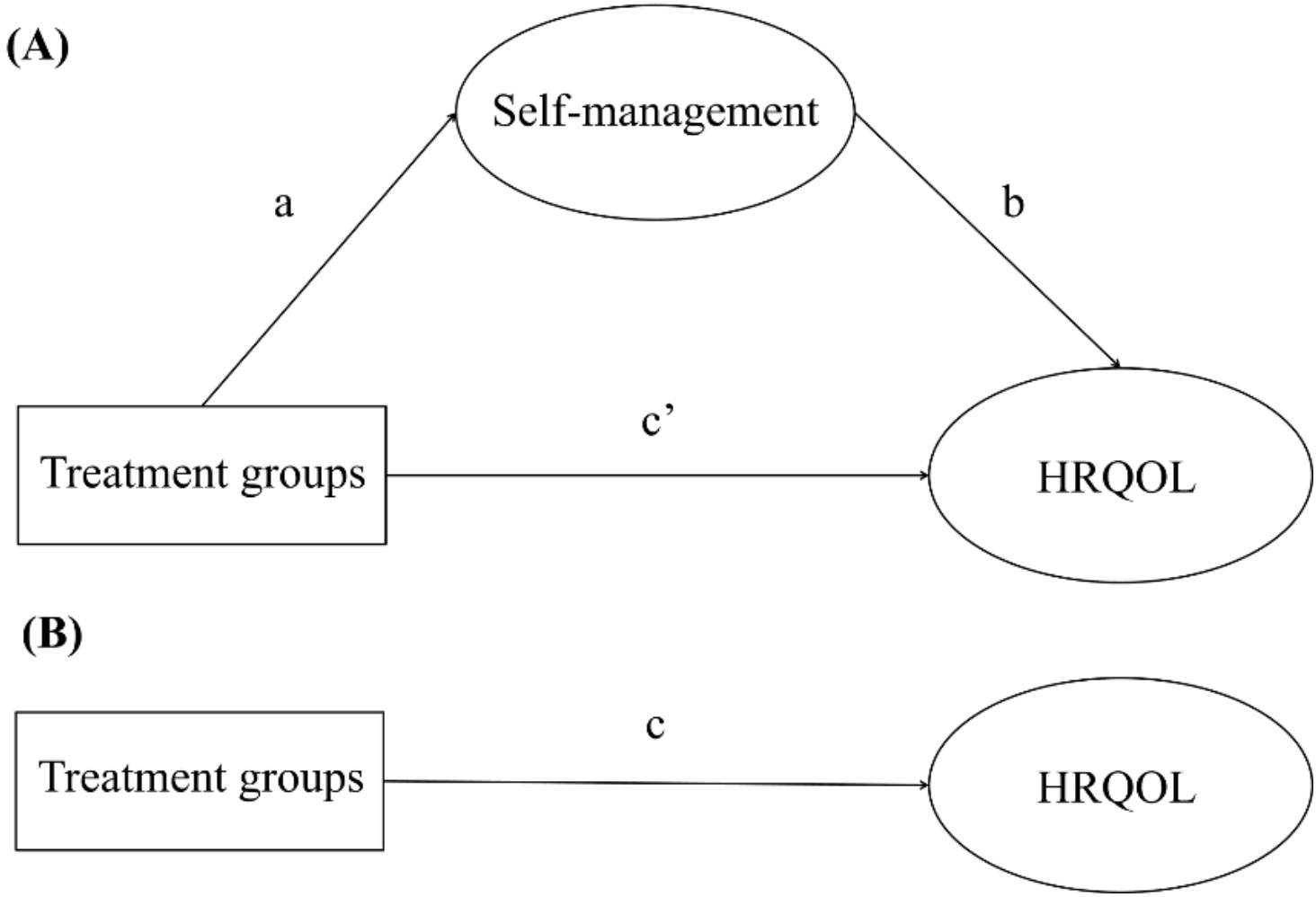

Figure 1

(A): Single-mediator model, (B): Unmediated treatment effect. Explaining: Boxes indicated manifest measurement variables, ovals indicated latent variables operationalised by manifest indicators (Figure 1(A)). A binary indicator for the study treatment groups predicted a potential mediator self-management (path a) and the mediator self-management predicted HRQOL (path b). The study treatment groups indicator predicted that a HRQOL that was not explained by the mediated path ab as path c'. The total unmediated effect of the intervention was path c (Figure 1(B), when no mediators were included in the model).

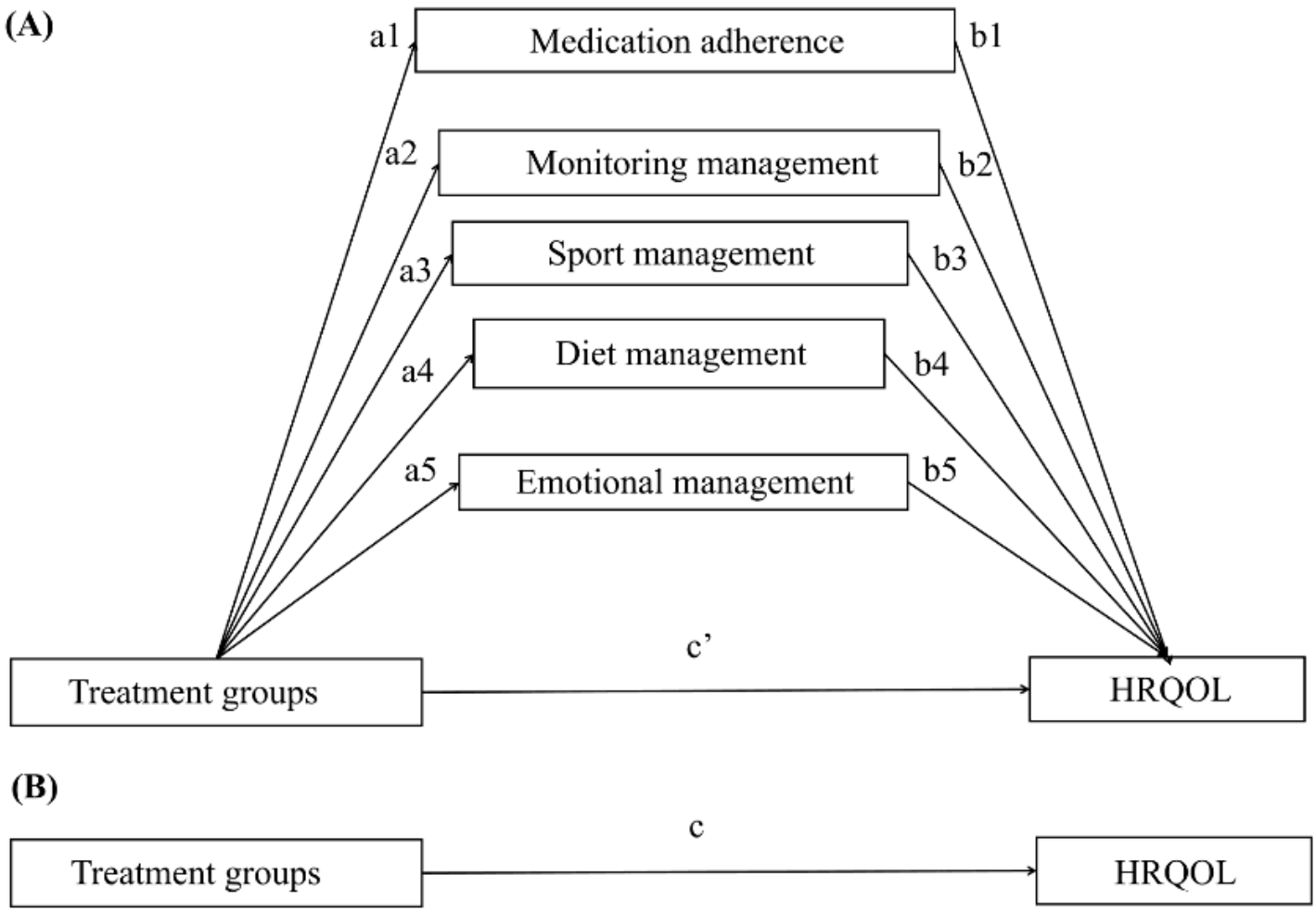

Figure 2

(A): Multiple-mediator model, (B): Unmediated treatment. Explaining: Path analytic models were used to assess multiple-mediator models, in which all five potential mediators were utilized, each with a path from the study treatment groups variable to the mediator (paths a1-5, Figure 2(A)), and from the mediator-predicted HRQOL (paths b1-5). The total unmediated effect of the treatment was path c (Figure 2(B)).

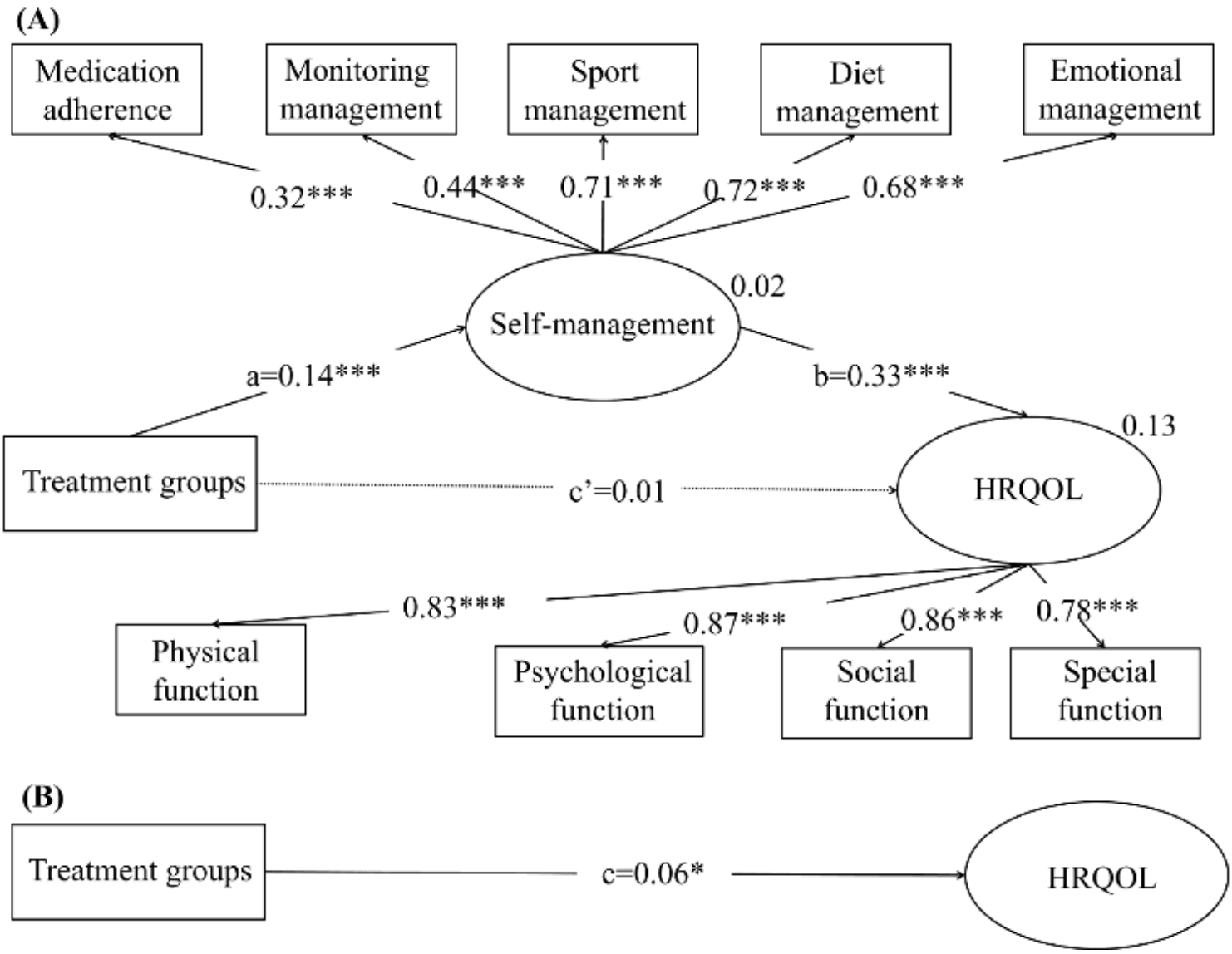

Figure 3

Structural equation model of the treatment groups, hypertension self-management, and HRQOL. All path coefficients are standardized. Data represent standardised regression coefficients (β) for paths or squared multiple correlations (R2) for variables, and are adjusted for body mass index (BMI), family history, duration of hypertention, and life styles. Boxes indicate manifest measurement variables; ovals indicate latent variables operationalised by manifest indicators; error terms are not displayed for ease of presentation. The indirect effect of treatment groups on HRQOL via self-management was 0.05 (95% CI:0.02-0.07), p<0.001; Indication of two-sided significance: *p<0.05; ***p<0.001.