Observational Study

Medicine

OPEN

The relationship between hypertension and physical activity in middle-aged and older adults controlling for demographic, chronic disease, and mental health variables

Ying Tian, PhD[a], Yaqun Zhang, PhD[b,*]

Abstract

To explore the relationship between hypertension and physical activity (PA) in the middle-aged and elderly after controlling demographic characteristics, chronic diseases and mental health variables. The 2018 China Health and Retirement Longitudinal Study (CHARLS) was used to collect the data. A baseline survey of middle-aged and older people was carried out nationally using the PPS sample method to look into their demographic, health state, and other information. The investigation included 4593 adults over 50 with complete data on PA level and hypertension prevalence. Z-test, logistic regression analysis, and linear hierarchical regression analysis were performed on the gathered data using the SPSS 27.0 program. The prevalence of hypertension among middle-aged and senior persons was 12.2%, and the percentage of those who did not have it was 87.8%. Males were more likely than females to have hypertension. Participants who reported high levels of PA made up 49.2% of the total, while those who reported low levels of PA made up 50.8% of the total. High levels of PA were significantly inversely correlated with hypertension ($P < .05$). There was still a statistically significant relationship between PA and hypertension ($P < .05$) after controlling demographic factors (gender, age, household registration type, education level, widowhood), chronic disease (arthritis, diabetes, disability, asthma, self-assessment of health, memory disease, stroke, hyperlipidemia) and mental health variables (bad mood and depression). High-level PA is significantly related to the low risk of hypertension. After controlling demographic characteristics, chronic diseases and mental health variables, this correlation is still significant.

Abbreviations: BMI = body mass index, CHARLS = China health and retirement longitudinal study, CI = confidence interval, MET = metabolic equivalent of energy, OR = odds ratio, PA = physical activity, RCT = randomized controlled trial, RRAS = renin-angiotensin-aldosterone system.

Keywords: hypertension, middle-aged and elderly people, physical activity, variables

1. Introduction

One of the greatest risk factors for cardiovascular illnesses is hypertension, which can also cause early death or disability.[1,2] A study indicated that 44.7% of Chinese individuals between the ages of 35 and 75 had hypertension.[3] The international economy has developed quickly, and this has resulted in significant changes in people's lifestyles.[4] It is anticipated that there will be 1.56 billion hypertensive individuals worldwide by 2025.[5] Older age, less PA, less sleep, being sedentary, and bad eating habits are all thought to raise the risk of hypertension in people.[6] Therefore, it is necessary to find out effective prevention techniques to reduce the prevalence of hypertension symptoms. Regular PA is linked to positive physiological changes in the human body as well as benefits to general health.[7] Regular PA and exercise are reported to be essential ways to prevent and manage hypertension, according to evidence from observational and clinical research.[8] Through intricate biochemical mechanisms, regular exercise and PA can lower the risk of developing hypertension.[9] Middle-aged and older persons can utilize PA and exercise alone to treat and prevent the development of hypertension, as well as in conjunction with medication to treat and prevent the symptoms of hypertension.[10] In order to avoid hypertension, it is recommended that each week you engage in at least 150 minutes of moderate intensity PA and exercise or 75 minutes of intensive intensity PA and exercise.[11] PA and the incidence of hypertension were shown to be adversely associated, according to a systematic review of a prospective cohort research.[12] The idea that physical exercise and hypertension had a negative connection was also corroborated by another systematic review and meta-analysis.[11] According

This study was supported by the University Sports Development and Application Research Fund of China Association of Higher Education (21TYZD04)and the major scientific research project of Shenyang Normal University in 2020 (ZD202004).

The datasets generated during and/or analyzed during the current study are publicly available.

[a] College of Sports Science, Shenyang Normal University, Shenyang, China, [b] College of Sports Science, Anshan Normal University, Anshan, China.

**Correspondence: Yaqun Zhang, College of Sports Science, Anshan Normal University, No.43, Tiedong District, Anshan, Liaoning, China (e-mail: 18940126315@163.com).*

How to cite this article: Tian Y, Zhang Y. The relationship between hypertension and physical activity in middle-aged and older adults controlling for demographic, chronic disease, and mental health variables. Medicine 2022;101:47(e32092).

Received: 21 October 2022 / Received in final form: 8 November 2022 / Accepted: 8 November 2022

http://dx.doi.org/10.1097/MD.0000000000032092

to Konkor's research,[13] employment requiring moderate PA are less likely to cause hypertension than sedentary jobs. According to Nagata JM's research,[14] the incidence of hypertension increased by 2% while the PA score declined by 1 unit annually. So far, most studies have shown that there is a close relationship between PA and hypertension. However, studies on the effects of demographic factors, other chronic diseases and mental health variables on PA and hypertension are few and need further research.[10,15] Therefore, the purpose of this study was to investigate whether symptoms of hypertension in the middle-aged and elderly in China are associated with PA levels after controlling for demographic characteristics, chronic disease, and mental health conditions.

2. Methods

2.1. Participants and data

CHARLS is a large-scale interdisciplinary survey project implemented by Peking University in China.[15] The purpose is to collect data on demographic information, physical and mental health, personal and family economic status, medical services, and insurance of middle-aged and elderly people aged 45 and above in China, for the analysis of China's population aging and to promote interdisciplinary research on aging. CHARLS adopts the multi-stage probability scale proportional sampling method, and conducts sampling through 4 stages of county (district)-village (resident)-household-individual. In our study, CHARLS 2018 data was used. All data collected in CHARLS are kept in the CHARLS database of Peking University, China. All data can be found at http://charls.pku.edu.cn. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of College of Sports Science, Shenyang Normal University (protocol code 043, protocol approved on July 3, 2022).

2.2. Variables

2.2..1. Demographic, chronic disease, and mental health variables. Gender (male or female), age (50–59, 60–69, 70–79, 80–89, and 90 and above), household registration type (urban or rural), education levels (below high school or high school above), and widower status are among the demographic factors. Chronic disease variables included arthritis (yes or no), diabetes (yes or no), disability (yes or no), asthma (yes or no), self-rated health (good or bad), memory disorders (yes or no), stroke (yes or no), and hyperlipidemia (yes or no). Mental health variables included bad mood (yes or no) and depression (yes or no).

2.2..2. Physical activities. Through the questionnaire survey, we know that the physical activities of middle-aged and elderly people include carrying heavy objects, digging, farming and other activities that consume a lot of physical strength. Including mopping the floor, playing Taijiquan, walking, entertainment, mahjong and other low physical activities. Then, the number of days and the duration of daily activities of the participants for each PA for at least 10 minutes were evaluated. The duration of each PA is evaluated as < 0.5 hour, greater than or equal to 0.5 hour but less than 2 hours, greater than or equal to 2 hours but less than 4 hours, and > 4 hours. According to the International Physical Activity Scale,[16] the PA level was estimated. Total PA per week was calculated by metabolic equivalent × hour/week and divided into 2 groups: ≥23 MET·h·week^{-1} (high PA) or < 23 MET·h·week^{-1} (low PA).

2.2..3. Hypertension. A qualified physician to test the participants' blood pressure (Omron hem-7200 monitor, battery and stopwatch) used an electronic sphygmomanometer. Before taking blood pressure readings, the study participants rest in a sitting position for at least 5 minutes. Then they read the data 3 times every 5 minutes. Calculate the average of the 3 readings. At present, according to China's effective recommendations on hypertension, participants' systolic or diastolic blood pressure is greater than 140 or 90 mm Hg, and participants are considered as hypertensive. Or individuals who self-reported using antihypertensive medications in the previous 2 weeks were included in the study.

2.3. Statistical analysis

All listed variables are first described statistically. Multivariate logistic regression was used to analyze the risk factors of hypertension and PA respectively. In order to evaluate the correlation between PA and the possibility of hypertension, multi-level linear regression analysis was performed with hypertension as the dependent variable and PA level as the independent variable to determine the relationship between PA and the possibility of hypertension. The *P* value of PA and hypertension is obtained in model 1. Model 2 predicts demographic variables (household registration status, education level, gender, age and widowhood) based on Model 1. Model 3 predicts chronic diseases and mental health status variables (arthritis, bad mood, diabetes, disability, asthma, self-rated health, memory diseases, stroke, hyperlipidemia, depression) on the basis of Model 2. For all statistical analysis, a *P* value less than .05 is considered to be statistically significant. Using IBM SPSS Statistics 27.0 for all statistical analysis (IBM SPSS Inc., Chicago, IL).

3. Results

3.1. Demographic characteristic

A total of 4593 respondents over 50 years old were included in this study. Among them, 2263 cases were male (49.3%), less than 2330 cases were female (50.7%), and there was no statistical significance in gender and PA of participants ($P > .05$) through Z-test. In terms of symptoms of hypertension, the proportion of people with hypertension was 12.2%, and that without hypertension was 87.8%. Participants with high PA accounted for 49.2%, while those with low PA accounted for 50.8%. Participants aged 50 to 59, 60 to 69, 70 to 79, 80 to 89, 90 and above accounted for 6.0%, 16.0%, 36.0%, 34.9%, and 7.0%, respectively. In terms of household registration types, rural household registration accounts for 77.9% and urban household registration accounts for 22.1%. In terms of education level, high school and above account for 19.5%, and junior high school and below account for 80.5%. The number of widowed participants accounted for 10.9%, and the number of unmarried participants accounted for 89.1%. 24.8% of the participants rated their health as good, and 75.2% rated their health as bad. The number of participants with disabilities accounted for 3.6%, and that without disabilities accounted for 96.4%. In terms of chronic diseases, participants with hyperlipidemia accounted for 13.5%, those with diabetes accounted for 7.7%, those with stroke accounted for 6.2%, those with asthma accounted for 1.7% and those with arthritis accounted for 7.1%. The number of participants with smoking habits accounted for 26.2%, the number of participants who could walk 1 kilometer accounted for 83.1%, and the number of participants with depressive symptoms accounted for 33.8%. Except gender and PA, there are statistical differences in Z test results among other variables ($P < .05$) (Figure 1 and Table 1).

3.2. Analysis of influencing factors of hypertension

Statistically significant differences were found between gender, age, self-rated health status, hyperlipidemia, diabetes, poor mood, arthritis, asthma, depression, and PA volume and participants'

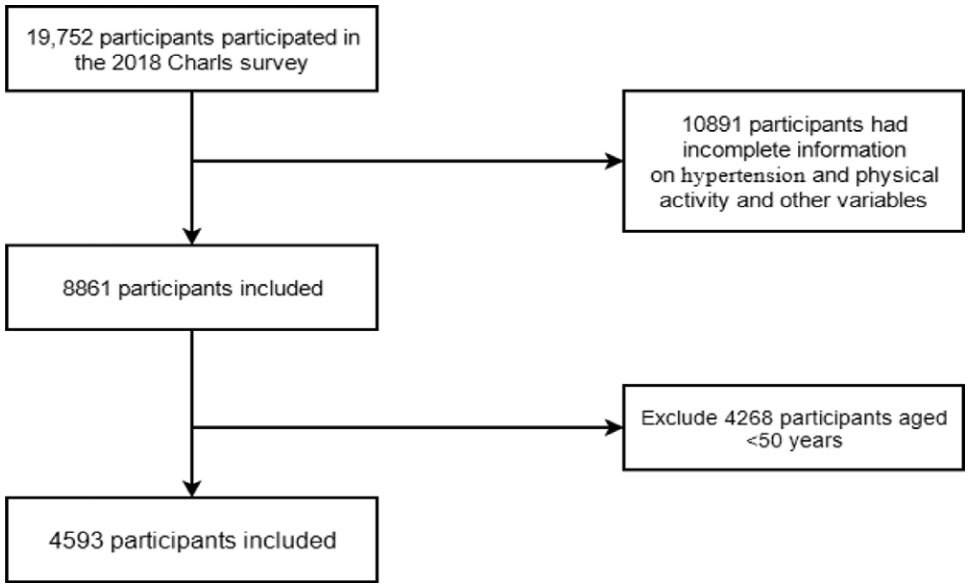

Figure 1. A total of 19752 participants participated in the 2018 China Health and Retirement Longitudinal Study (Charls), and 10891 people were excluded because of incomplete information on hypertension, physical activity and other variables, with 8861 remaining. 4268 people were excluded from 8861 because they were younger than 50 years old. Finally, the remaining 4593 participants were included in the study.

hypertension ($P < .05$). Older men were more likely to have high blood pressure than older women OR = 1.412 (95%CI = 1.114–1.789). The older you are, the higher the risk of hypertension in the middle-aged and elderly population OR = 1.139 (95%CI = 1.002–1.294). Regarding health status, the middle-aged and elderly people with worse self-rated health status were more likely to suffer from hypertension OR = 0.614 (95%CI = 0.465–0.812). Participants with hyperlipidemia OR = 1.214 (95%CI = 1.162–1.582), diabetes OR = 1.401 (95%CI = 1.280–1.873), arthritis OR = 1.339 (95%CI = 1.235–1.491), and asthma OR = 1.134 (95%CI = 1.010–1.431) were more likely to have hypertension. Participants with poor mood OR = 16.132 (95%CI = 1.947–133.702), depressed OR = 1.302 (95%CI = 1.006–1.686), and low PA momentum OR = 0.750 (95%CI = 0.583–0.967) were more likely to have high blood pressure in terms of mental health and PA (Table 2).

3.3. Analysis of influencing factors of PA

Gender, age, disability, stroke, bad mood, arthritis, smoking, walking 1 kilometer ability and depression were significantly correlated with PA level ($P < .05$). Compared with female participants, the amount of PA of male participants was at a high level of OR = 0.874 (95% CI = 0.783–0.986). With the increase of age, the level of PA of participants became lower and lower, OR = 0.678 (95% CI = 0.545–0.856). There was a negative correlation between disability and high PA, OR = 0.489 (95% CI = 0.365–0.697). Participants with stroke OR = 0.532 (95% CI = 0.389–0.675) and arthritis OR = 0.464 (95% CI = 0.325–0.789) were negatively associated with high PA. The amount of PA of the participants with smoking habit OR = 1.325 (95% CI = 1.153–1.545) was significantly higher than that of the participants without smoking habit. The PA of the participants without depressive symptoms (OR = 0.156 [95% CI = 0.134–0.185] and with good walking ability of 1 km (OR = 2.330 [95% CI = 1.876–2.753]) was at a high level (Table 3).

3.4. Linear hierarchical regression model of hypertension and PA level of participants

Model 1 shows that there is a significant correlation between PA and hypertension ($P < .05$). Model 2 adjusts the demographic variables (household registration type, education level, gender, age, whether or not you are widowed) based on PA, and the results are also significantly correlated ($P < .05$). Model 3 after adjusting the health characteristics and living habits (arthritis, bad mood, diabetes, disability, asthma, self-rated health, memory disease, stroke, hyperlipidemia, depression) based on Model 2, the results were still significantly correlated ($P < .05$) (Table 4).

4. Discussion

In this study, logistics regression model and linear hierarchical regression model were used to analyze the relationship between hypertension and PA level of middle-aged and elderly people ($P < .05$). Demographic characteristics (gender, age, household registration type, education level, widowhood) and health characteristics (arthritis, bad mood, diabetes, disability, asthma, self-rated health, memory diseases, stroke) were adjusted. Our research results show that the proportion of middle-aged and elderly people suffering from hypertension is 12.2%, and that of people without hypertension is 87.8%. 49.2% of middle-aged and elderly people have high PA level, and 50.8% have low PA level. The number of middle-aged and elderly people with high PA level is significantly lower than those with low PA, which indicates that participating in high PA can reduce the risk of hypertension among middle-aged and elderly people. This result has been supported by a previous study by You Y et al.[19] They recruited 7113 people over the age of 45 and established a decision tree model to analyze the importance of different levels of PA for hypertension prevention. Participants who participated in high-intensity PA for more than 10 minutes were found to be less likely to have high blood pressure. Thus, the study concluded that high intensity PA was more effective in preventing hypertension than moderate and light intensity PA. Huang B et al[20] included a review to analyze the scientific evidence for the antihypertensive effect of aerobic PA in RCTs of patients with hypertension. The results showed that regular medium and high intensity aerobic activities could significantly reduce the blood pressure of patients with hypertension. The study concluded that in today's society, the prevalence of hypertension and the proportion of low PA are high and increasing, and that PA plays an important role in the treatment of hypertension as a separate or additional therapy. This is consistent with the conclusion of

Table 1

Characteristics of middle-aged and elderly participants of the CHARLS in 2018.

		Number of participants	%	Z	*P*
Gender	Male	2263	49.3%		
	Female	2330	50.7%	1.060	.289
Age (yr)	50–59	276	6.0%		
	60–69	736	16.0%		
	70–79	1655	36.0%		
	80–89	1605	34.9%		
	≥90	321	7.0%	–58.370	.000
Location of residence	City	1015	22.1%		
	Rural	3578	77.9%	37.932	.000
Degree of education	Junior high school and below	3699	80.5%		
	High school and above	894	19.5%	–41.583	.000
Widowed	Yes	501	10.9%		
	No	4092	89.1%	53.157	.000
Self-rated health status	Good	1138	24.8%		
	Bad	3455	75.2%	34.309	.000
Physical disability	Yes	166	3.6%		
	No	4427	96.4%	63.023	.000
Hyperlipemia	Yes	620	13.5%		
	No	3973	86.5%	49.564	.000
Diabetes	Yes	353	7.7%		
	No	4240	92.3%	57.516	.000
Stroke	Yes	285	6.2%		
	No	4308	93.8%	59.430	.000
Bad mood	Yes	45	1.0%		
	No	4548	99.0%	66.564	.000
Memory disease	Yes	112	2.4%		
	No	4481	97.6%	64.590	.000
Arthritis	Yes	324	7.1%		
	No	4269	92.9%	58.320	.000
Asthma	Yes	78	1.7%		
	No	4515	98.3%	65.569	.000
Smoke	Yes	1203	26.2%		
	No	3390	73.8%	32.307	.000
1 km walking ability	Good	3819	83.1%		
	Bad	774	16.9%	–45.108	.000
Depression	Yes	1551	33.8%		
	No	3042	66.2%	22.029	.000
Hypertension	Yes	560	12.2%		
	No	4033	87.8%	51.420	.000
Physical activity level	High	2257	49.2%		
	Low	2336	50.8%	1.090	.276

CHARLS = China health and retirement longitudinal study.

this study, which also believes that the importance of PA for the prevention of hypertension in the middle-aged and elderly people over 50 years old should be increased awareness of PA and adhere to physical exercise.

In addition, our survey showed that the low level of PA was positively correlated with hypertension, which meant that the middle-aged and elderly people with low level of PA were more likely to develop hypertension. This result was consistent with that of Treff C et al,[21] who recruited 15,105 participants to study the relationship between leisure time PA, commuting time-related PA and hypertension. Associations between PA and high blood pressure were obtained by Poisson regression after adjustment for age, race, education, income, body mass index (BMI), diabetes, and sodium and alcohol intake. The results showed that participants with high PA had a lower prevalence of hypertension than those with low PA, and the study concluded that the level of PA was significantly correlated with hypertension and that high PA reduced the risk of hypertension. Barengoc et al[22] conducted a study to assess whether low PA levels, low occupational and low commuting PA increased the risk of hypertension among adults after adjusting for most hypertension risk factors and different forms of PA. 12,162 Finnish adults aged 25 to 64 were enrolled in the study. The results showed that high level of leisure time sports activities were related to the reduction of hypertension risk. Promoting leisure time sports activities was crucial for the prevention of hypertension. Therefore, when formulating the exercise prescription for the elderly patients with hypertension, we should formulate the content of high exercise intensity suitable for their physical characteristics in combination with the health status of the elderly with hypertension. Such exercise prescription is safe and effective for the treatment of hypertension in the elderly.

Several possible mechanisms of the relationship between PA and hypertension have been proposed and tested. Impaired endothelial vasodilation is one of the risk factors of hypertension, and proper PA can improve or repair the impaired endothelial vasodilation and thus reduce the risk of hypertension.[23] Atherosclerosis should also be considered as one of the risk factors for hypertension in the elderly. The increase of arterial stiffness in the elderly leads to the decrease of arterial compliance and blood pressure buffering capacity. Appropriate PA can improve the symptoms of arteriosclerosis in middle-aged and elderly people, and make the arteries of the elderly return to normal functions, thus reducing the risk of hypertension in middle-aged and elderly people.[24] Sympathetic nervous system and renin-angiotensin-aldosterone system play an important role in normal and healthy people. They can regulate the cardiovascular function of human body, such as heart rate

Table 2

Influencing factors of hypertension among middle-aged and elderly participants in CHARLS in 2018.

							95%CI	
	Hypertension	B	SE	Wald	*P*	Exp(B)	Lower	Upper
Yes	Gender	0.345	0.121	8.143	**.004**	1.412	1.114	1.789
	Age (yr)	0.13	0.065	3.959	**.047**	1.139	1.002	1.294
	Location of residence	0.213	0.144	2.173	.14	1.237	0.932	1.641
	Degree of education	0.087	0.156	0.313	.576	1.091	0.804	1.48
	Widowed	–0.114	0.185	0.378	.539	0.892	0.621	1.283
	Self-rated health status	–0.487	0.142	11.759	**.001**	0.614	0.465	0.812
	Physical disability	–0.279	0.277	1.02	.313	0.756	0.44	1.301
	Hyperlipemia	0.717	0.357	13.199	**0**	1.989	1.614	2.371
	Diabetes	0.886	0.431	11.129	**0**	1.377	1.118	1.671
	Stroke	0.257	0.21	1.497	.221	1.293	0.856	1.953
	Bad mood	2.781	1.079	6.642	**.01**	16.132	1.947	133.702
	Memory disease	0.089	0.324	0.076	.783	1.093	0.58	2.062
	Arthritis	1.081	0.188	33.004	**0**	1.339	1.235	1.491
	Asthma	0.796	0.431	10.191	**0**	1.134	1.01	1.431
	Smoke	–0.251	0.133	3.579	.059	0.778	0.599	1.009
	1 km walking ability	–0.115	0.166	0.482	.488	0.891	0.643	1.234
	Depression	0.264	0.132	4.021	**.045**	1.302	1.006	1.686
	Physical activity level	–0.287	0.129	4.941	**.026**	0.75	0.583	0.967

CHARLS = China health and retirement longitudinal study, CI = confidence interval.

Table 3

Influencing factors of physical activity among middle-aged and elderly participants in CHARLS in 2018.

							95%CI	
	Physical activity level	B	SE	Wald	*P*	Exp(B)	Lower	Upper
High	Gender	–0.123	0.061	3.678	**.035**	0.874	0.783	0.986
	Age (yr)	–0.423	0.132	9.786	**.000**	0.678	0.545	0.856
	Location of residence	–0.034	0.081	0.124	.714	0.976	0.832	1.177
	Degree of education	–0.121	0.081	2.132	.133	0.889	0.787	1.131
	Widowed	–0.047	0.098	0.193	.677	0.967	0.797	1.175
	Self-rated health status	0.096	0.073	1.976	.176	1.109	0.976	1.225
	Physical disability	–0.771	0.176	18.179	**.000**	0.489	0.365	0.697
	Hypertension	–0.165	0.095	2.876	.092	0.865	0.731	1.223
	Hyperlipemia	–0.043	0.110	0.176	.658	0.956	0.811	1.155
	Diabetes	0.087	0.121	0.432	.521	1.112	0.865	1.376
	Stroke	–0.678	0.141	25.432	**.000**	0.532	0.389	0.675
	Arthritis	–0.376	0.121	10.874	**.000**	0.464	0.325	0.789
	Asthma	–0.165	0.232	0.465	.477	0.876	0.575	1.234
	Smoke	0.232	0.086	10.457	**.000**	1.325	1.153	1.545
	1 km walking ability	0.723	0.087	86.183	**.000**	2.330	1.876	2.753
	Depressive symptoms	–1.874	0.077	721.167	**.000**	0.156	0.134	0.185

CHARLS = China health and retirement longitudinal study, CI = confidence interval.

Table 4

Linear hierarchical regression model of hypertension and physical activity level of participants.

				Variation statistics		
Model	R	R^2	Adjusted R^2	R^2 variation	F variation	*P*
1	0.124*	0.015	0.015	0.015	71.729	**.000**
2	0.141†	0.020	0.019	0.005	4.279	**.000**
3	0.599‡	0.359	0.356	0.339	186.175	**.000**

*Predicted variable: physical activity

†Predicted variables: physical activity, gender, household registration type, education level, age, widowhood.

‡Predicted variables: physical activity, household registration type, education level, gender, age, widowhood, arthritis, bad mood, diabetes, disability, asthma, self-rated health status, memory disease, stroke, hyperlipidemia, depression.

and blood pressure.[25] If the dysfunction of sympathetic nervous system and renin-angiotensin-aldosterone system can lead to the dysfunction of cardiovascular system. Proper PA can improve or repair the functions of sympathetic nervous system and renin-angiotensin-aldosterone system, and then restore the body's control over the normal functions of cardiovascular system, so that the body's heart rate and blood pressure are within the normal range.[26] Abnormal glucose metabolism and islet function in the human body will increase the body's risk of hypertension,[27] while physical exercise will improve the body's glucose metabolism and islet function.[28] Physical exercise can further improve the body's regulation of blood pressure by improving the glucose metabolism and islet function, to stabilize blood pressure in the normal range. The damaged structure and function of the left ventricle in human body will lead to ischemia under the endocardium and coronary artery stenosis, which will lead to hypertension in the body.[29] Physical exercise increases the myocardial thickness, promotes the improvement of cardiac function, and improves the inner diameter and elasticity of coronary arteries, thereby improving the cardiac function of the body and reducing the risk of hypertension in the

body.[30] The above studies have found that hypertension and impaired endothelial vasodilation, arteriosclerosis, dysfunction of the sympathetic nervous system and renin-angiotensin-aldosterone system, abnormal glucose metabolism, dysfunction of pancreatic islets, and structural damage of left ventricle are all one of the risk factors for hypertension. Physical exercise can have a positive effect on these risk factors for hypertension, which will provide an important reference for the treatment of hypertension caused by different causes.

Our model also quantified the effects of demographic variables on the relationship between hypertension symptoms and PA. Considering the influence of gender and age, we found that the depression level of middle-aged and old men was higher than that of middle-aged and old women, and the older the man was, the higher the risk of hypertension was. This is consistent with previous studies by Spra B et al[31] who recruited 7443 South African citizens over the age of 15 to assess whether nontraditional risk factors such as race, geographical location, social stressors and psychological distress increased the risk of high blood pressure. Stepwise regression was used to analyze the relationship between demographic characteristics, socio-economic, life stress and health risk factors and hypertension. The results showed that the elderly, men, people with diabetes or a family history of high blood pressure, and people living in cities were at higher risk of high blood pressure. Aging is one of the risk factors for hypertension in the elderly. This study found that with the increase in age, the risk of high blood pressure in the elderly becomes higher and higher. This result was consistent with that of Chorbar S et al,[32] who adopted the 4-stage stratified random sampling survey to investigate the young people aged 15 to 44 in Chongqing, aiming to explore the relationship between prehypertension and PA time in young people. The results showed that the prevalence of prehypertension among the youth population in Chongqing was 45.7%. The prevalence rate in males (54.7%) was higher than that in females (36.6%). Age, smoking, alcohol consumption, family history, BMI, body fat percentage, waist circumference, educational background, moderate to low intensity PA time, and sedentary behavior were all significantly correlated with prehypertension. Hypertension in the elderly is mainly a systolic abnormality that is thought to be due to changes in large arteriosclerosis. However, aging decreases the elasticity of vascular smooth muscle and increases the risk of arteriosclerosis, further increasing the risk of hypertension.[33]

The results of this study showed that the health conditions of the middle-aged and elderly (self-rated health, hyperlipidemia, diabetes, poor mood, arthritis, asthma, and depression) could affect the relationship between hypertension and PA. We found that middle-aged and elderly people who think they are in poor health, hyperlipidemia, diabetes, arthritis, asthma, bad mood and depression are more likely to suffer from hypertension, which is partially consistent with the previous research of Gu H et al.[34] They evaluated and compared the PA patterns of urban and rural residents in China, and studied their relationship with obesity, hypertension and diabetes. They studied 46,285 subjects between the ages of 35 and 70 years from the baseline survey of the study in China. The level of PA was assessed using the International Physical Activity Questionnaire and all subjects were measured for weight, height, waist and hip circumference, blood pressure, and fasting blood glucose. The results showed that PA had a negative correlation with obesity, hypertension and diabetes, and PA should be promoted to improve and prevent hypertension and diabetes. Jones FM[35] evaluated the relationship between community social characteristics, disease, and chronic disease outcomes in a representative longitudinal sample of adults in Los Angeles County, California. In the study of 900 adults, he looked at 3 health outcomes for adults: high blood pressure, obesity and depression. He analyze that collected data use a multistage logistic regression model. The research results show that adults with physical diseases have a higher risk of hypertension, which is consistent with the results of this study. People with multiple chronic diseases should pay attention to their increased risk of hypertension.

The results of this study have shown that patients with lung diseases such as asthma are more likely to have hypertension, which is consistent with the conclusion of the study by Jun-Hwan J et al.[36] They assessed the relationship between the PA level of patients with chronic obstructive pulmonary disease and the incidence of hypertension using data from the fifth Korea national health and nutrition examination survey conducted from 2010 to 2012. a total of 1243 patients with chronic obstructive pulmonary disease aged 40 or over were enrolled in the study and cross-classified according to their PA level. The correlation between the level of PA and the incidence associated with hypertension was assessed by cross-over and logistic regression analyses. The results showed that moderate PA could reduce the risk of hypertension in patients with chronic obstructive pulmonary disease. Physical exercise has been proved to improve human health, cardiovascular function, respiratory function and motor system function, and thus reduce the risk of high blood pressure in the middle-aged and elderly.[37,38] Mos L et al[39] recruited 454 hypertensive patients without left ventricular hypertrophy and evaluated the long-term effect of regular PA on the development of left ventricular hypertrophy in hypertensive subjects. The study concluded that regular PA could prevent left ventricular hypertrophy in hypertensive subjects, and both leisure and competitive sports activities could have a positive impact on left ventricular quality in hypertensive subjects. Middle-aged and elderly people should take regular physical exercise, which can not only reduce the risk of high blood pressure but also cardiovascular function, respiratory function and motor system function.

In addition, the results of this study showed that the risk of hypertension in the elderly who could suffer from depressive symptoms and poor mood was significantly higher than that in the elderly who did not suffer from depressive symptoms and were in good mood. This finding was consistent with the results of CGS Araújo et al,[40] who recruited 231 community-based seniors to assess the relationship between depression and hypertension among the community-based seniors and the effect of covariates on the relationship. Covariate information for participants was as follows: sex, age, race, smoking habits, level of PA, BMI, and diabetes mellitus. Depression was screened using the Geriatric Depression Scale. The presence of hypertension is defined by self-reported data and/or the use of antihypertensive drugs. A logistic regression analysis was performed on the obtained data, and the results showed that the depressive symptoms of the elderly were significantly correlated with hypertension, and the relationship between the 2 was directly affected by the level of PA, BMI, and diabetes. Studies[41] have shown that the control function of the autonomic nervous system in patients with depression will become abnormal changes, characterized by deteriorating vagal control function and increased heart rate, which may be one of the reasons why depressive symptoms increase the risk of hypertension.

5. Conclusion and limitations

The PA level of the middle-aged and elderly is closely related to the condition of hypertension, but the research on the PA and hypertension of the middle-aged and elderly in China is at the initial stage. In this study, the proportion of middle-aged and elderly women with hypertension was significantly lower than that of men, and the risk of hypertension in the middle-aged and elderly people who participated in high PA was significantly lower than that in the low level of PA. At the same time, middle-aged and elderly people with gender, advanced age, poor self-assessment health status, hyperlipidemia, diabetes, arthritis, asthma, poor mood and depression were more likely to suffer from symptoms of hypertension. This study will help to better

understand the relationship between hypertension symptoms and PA in the elderly, and provide a new basis for developing a scientific and effective exercise prescription to prevent and treat hypertension symptoms in the elderly.

A number of restrictions also have an impact on our research. First off, after adjusting for population characteristics and variables relating to physical and mental health status, this study only reveals the association between PA and hypertension. It also establishes the relationship between PA level and hypertension. We found that the potential mechanism information of PA affecting hypertension includes improving impaired endothelial and cardiac function, arteriosclerosis, sympathetic nervous system and RAAS dysfunction. It is necessary to further explore whether there is information about other potential mechanisms of PA affecting hypertension. Second, we have proved that there is a correlation between PA level and hypertension in middle-aged and elderly people in China. We need to expand the sample size of the survey and further explore the relationship between PA and hypertension in China to determine the validity of the conclusions of this study, because there may be regional differences in the correlation between PA and hypertension. Third, the results of this study may not be reliable because it did not account for aged people with other chronic diseases.

Acknowledgments

The authors thank all the participants in CHARLS team for their time and effort devoted to the project.

Author contributions

Conceptualization: Ying Tian, Yaqun Zhang.
Data curation: Yaqun Zhang.
Formal analysis: Ying Tian, Yaqun Zhang.
Funding acquisition: Ying Tian.
Visualization: Ying Tian.
Writing – original draft: Ying Tian, Yaqun Zhang.
Writing – review & editing: Ying Tian, Yaqun Zhang.

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