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Self-Management and Blood Pressure Control in China: A Community Based Multicenter Cross-Sectional Study

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ABSTRACT

Objectives This study explored the relationship between self-management and blood pressure control in China.

Design A cross-sectional study.

Setting Eight community health centers from four cities in the northeast (Shenyang), northwest (Xi'an), southwest (Chengdu), and south (Changsha) of China.

Participants A total of 873 adults with hypertension, including 360 men and 513 women. Hypertension was defined as systolic blood pressure (SBP) ⩾ 140 mmHg and/ or diastolic blood pressure (DBP) ⩾ 90 mmHg.

Outcome measurements Outcomes included a patient reported survey to measure context, process and outcome variables from the individual and family self-management theory (IFSMT). Blood pressure control was categorized as good control if individuals with hypertension managed to reduce their blood pressure to < 140/90 mmHg, otherwise it was categorized as poor control. Data were analyzed using logistic regression models using SPSSv20.

Results A total of 67% (n=586) of participants had poor blood pressure control. Lower personal income (OR=1.50, 95% CI: 1.02-2.22) and limited outpatient care benefits in mainly rural residents (OR=2.22, 95% CI: 1.05-4.72) were associated with poor BP control. Longer disease duration was also a significant predictor of poor BP control (OR=1.03, 95% CI: 1.01-1.04). Self-management practices reduced the odds of having poor BP control (OR=0.98, 95% CI: 0.97-0.99).

Conclusions The individual and family self-management theory can serve as an effective theory for understanding the key contexts, processes, and outcomes essential for blood pressure control in China. Future research should evaluate the effect of a self-management intervention (e.g., self-monitoring, medication adherence, regular and routine doctor visits, and social supports) for blood pressure control in China using a multisite cluster randomized controlled trial. Sex and gender difference, cost and patient-reported outcomes should also be examined.

Strengths and Limitations of this study

- A strength is the use of the individual and family self-management theory (IFSMT) to guide the study.
- A strength is incorporation of a sex-based analysis.
- A strength is an attempt to use a surrogate marker of gender in the interpretation of results (level of education, personal income and employment status).
- A limitation is the use of the Self-management Scale for Patients with Hypertension. It has not been widely used and need further psychometric testing.
- A limitation of the study is the use of self-reported outcomes and the potential for reporting bias.

BACKGROUND

The prevalence of hypertension has increased worldwide.[1] It is the most significant risk factor of cardiovascular disease (CVD), accounting for nearly half of the cardiovascular morbidity and mortality in the world.[2-5] In China, hypertension is a serious public health problem; it has increased almost 400% from 1980 to 2015 (from estimated 59 million to 244.5 million),[6-8] and accounted for over 2 million deaths or 24.6% of all-cause mortality.[9] Hypertensive complications in China are similar to other countries, and include stroke, myocardial infarction, heart failure and chronic kidney disease.[10] Stroke is the leading cause of death and disability in China with an annual mortality of 1.6 million;[11] hypertension is the most important risk factor for stroke with the highest attributable risk at 34.6%.[11] Annual stroke healthcare expenditures are approximately￥40 billion (US$6.4 billion), causing a huge burden to the Chinese economy.[11] Domestic and international research studies have proved that adequate control of blood pressure reduces stroke,[12] CVD[13] and burden of disease,[14 15] and significantly improves health-related quality of life (HRQOL).[16 17]

The Chinese government launched the Chinese Basic Public Health Service Program in 2009, which provides a package of care that includes hypertension and diabetes screening and management in community health facilities. In many workplaces, free annual physical examinations are offered to individuals with this package of care. In 2013, the 17-country Prospective Urban Rural Epidemiology (PURE) study reported a hypertension awareness of 46.5%, treatment of 87.5%, and

control of 32.5%[2] and in 2017, the China Patient-Centered Evaluative Assessment of Cardiac Events (PEACE) study of 1.7 million individuals with hypertension suggested the prevalence of hypertension in China was 37.2%, with an awareness of 36%, treatment of 22.9%, and control of only 5.7%.[8] The prevalence of hypertension among men (41.9%) was higher than women (38.4%), treatment was 29.6% in men and 36.8% in women, and control was 6.5% in men and 7.4% in women.[18] These results suggest current governmental packages of care are insufficient to address the significant costs and burden of hypertension in China. These results also suggest there are sex- and/or gender-based differences. Gaps between governmental policy and clinical practice suggest additional strategies must be utilized to optimize hypertension primary prevention and treatment measures in China.[19]

Successful self-management strategies for individuals can result in effective control of blood pressure[20 21] and the sustainability of healthcare systems.[22] The individual and family self-management theory (IFSMT) suggests a dynamic model of self-management that consists of: 1) condition specific factors and physical/social environments (context), 2) knowledge and beliefs, self-regulation skills and abilities, and social facilitation (process), and 3) cost, health status, and HRQOL (outcomes).[23] Self-regulation includes the processes used to change behavior, such as setting goals, self-monitoring, reflective thinking, planning and participating in specific behaviors, management of responses, and self-evaluation.[23] Approaches to managing hypertension using the IFSMT within the Chronic Care Model[24 25] suggests individuals are active participants and work in partnership with healthcare providers

to improve outcomes.[26] A select number of intervention and longitudinal studies have found that self-regulation skills and abilities improve blood pressure outcomes.[20 27 28]

Most recently sex and gender difference have been gaining attention in the development and management of hypertension.[29-31] Women are twice as likely to have uncontrolled BP after menopause,[29] have a higher prevalence of obesity,[32] and are less likely to engage in physical activities[33] compared to men. Although the treatment benefit of antihypertensive agents may not differ between men and women,[34] women with hypertension are less likely to achieve recommended BP targets,[35 36] even with significantly higher use of antihypertensive medications.[36] Both sex and gender play important roles in predicting cardiovascular risk, and gender (social differences between men and women) has been reported to be more important than sex (biological difference between men and women) in predicting risk in multivariable models.[37 38] Disentangling the impacts of sex and gender in understanding male and female differences is increasingly recognized as an important aspect for addressing the knowledge gap in the field of hypertension healthcare. Despite this, gender has been less frequently evaluated due to inconsistencies in measurement. Smith[39] used level of education, hours of work, occupation segregation, and household responsibility to examine the feminine gendered role. Pelletier[37] devised the gender index to assess if the individual was the primary earner in their household, personal income, hours of work, and level of stress at home. However, no studies have examined the sex and gender aspects to blood pressure self-management in community residents with hypertension in China.

The aim of this study is to describe context and process variables within the IFSMT that impact hypertension control (outcomes) in men and women in China. This includes exploring both sex and gender aspects to self-management and BP control in Chinese adults living in the community.

METHODS

Study design and settings. Using a cross-sectional study design, individuals with hypertension were recruited from eight community health care centers in the northeast (Shenyang City), northwest (Xi'an City), southwest (Chengdu City), and south (Changsha City) of China from April 2015 to January 2016. Four geographic areas were chosen in an attempt to recruit a representative sample of individuals with hypertension in China.

Participants. Recruitment was conducted in four steps. First, forty national model community health centers accredited between 2011 and 2013 were purposely selected from the four cities in China.[40-42] These centers provide national standardized medical care to more than 100,000 individuals within a district in each of the four cities. Second, two community health care centers were randomly selected in each city from the forty national model community centers using a random number table for study participation. Third, 1048 individuals (131 from each community health center) who had been screened and diagnosed with hypertension within the past six months were randomly recruited from electronic health care information systems. Fourth, individuals were contacted to determine their interest in participating in a

telephone interview to learn more about the study.

Individuals who met the following inclusion criteria were recruited to participate: age ⩾ 18 years, SBP ⩾ 140 mmHg and/or DBP ⩾ 90 mmHg or prescribed antihypertensive medication for at least six months and able to identify their hypertensive medications within their medication schedule, able to read and write the Chinese language, and able to provide written informed consent to participate in the study. Individuals were excluded if they were pregnant, had cancer, or were cognitively impaired.

The study was approved by the Ethics Committee of Xi'an Jiaotong University Health Science Center. Well-trained research assistants explained the purpose and confidentiality of the study to participants and informed consent was obtained prior to survey completion.

Patient and public involvement. Patient and public involvement in research improves patient-centred care and management.[43] Before planning an intervention study, it was necessary to consult patients using this cross-sectional study design. Although patients did not inform the design or questions of this study, the study provided opportunity to engage with patients and the public across four geographic regions of China. The investigative team engaged with patients using the principles of inclusiveness, support, and mutual respect; and an opportunity to develop partnerships for co-building a future intervention study.[44] Results of this study will be communicated to patients using public forums in each of the four geographic regions. Public forums will foster patient partner collaborations for the intervention study.

Measurement. The IFSMT guided data collection and measurement.[23]

Context. Demographic (age, sex, marital status, education, personal income, and health insurance) data were collected by interview using investigator-developed questionnaires. Marital status was divided into two categories: married or single/divorced/widowed. Education was represented as: primary school or no formal education (< 6 years of schooling), high school (6-12 years of schooling), or college or higher (> 12 years of schooling). Personal income was divided into two categories: ⩽ ¥1500 (US$225) or > ¥1500 (US$225) based on the Chinese individual income tax rate.[45] Health insurance was divided into four categories: Urban Employees' Medical Insurance (UEMI), Urban Residents' Medical Insurance (URMI), New Rural Cooperative Medical Scheme (NCMS), or uninsured.

Risk behaviors included smoking (smoker [current smokers who smoked more than one cigarette daily]) or non-smoker [smoked fewer than 6 months and who never smoke before]) and alcohol consumption (consumer or non-consumer [consumed less than 1 glass per month and those who never drank before]). Family history of hypertension was defined as a blood relative such as mother, father, sister, or brother with hypertension (SBP ⩾ 140 or DBP ⩾ 90). Anthropometric measures included weight and height (body mass index [BMI]) and waist circumference [WC]). Body mass index was calculated as weight in kilograms divided by height in meters squared and classified into four levels according to the guidelines for prevention and control of overweight and obesity in Chinese adults: underweight (< 18.5), normal (18.5-23.9), overweight (24.0-27.9), and obese: (⩾ 28).[46-48] Waist circumstance (WC) was

divided into two categories: obese (men ⩾ 90cm, women ⩾ 80) and normal (men < 90cm, women < 80cm) according to the International Diabetes Federation[49] and National Institute for Health and Care Excellence.[50] Comorbidities were self-reported and based on a physician's diagnosis.

Process. The self-management scale for individuals with hypertension[51] used in this study was developed by the China Medical Foundation (CMB) community chronic disease management research group. Split-half reliability of the scale was 0.976 and Cronbach's alpha ranged from 0.853 to 0.868 on each of the 5 sub-scales. The five subscales contained 21 Likert scale items addressing: treatment management, diet management, physical exercise management, lifestyle management, and risk factor management. Subscale scores ranged from 1 to 5 and total scores ranged from 21 to 105, with higher scores indicating higher self-management behaviors (Supplementary File). In this this study, we converted the original subscale scores into standard scores for comparisons.

Outcomes. *Blood Pressure*. Blood pressure control was defined as a good if individuals had a SBP < 140 mmHg and DBP < 90 mmHg. Blood pressures were taken by trained nurses using a mercury sphygmomanometer according to the criterion formulated by the Chinese Hypertension League/National Center for Cardiovascular Disease (CHL/NCCD).[52] Two BP readings for each participant were obtained at 2-minute intervals in a sitting position and then averaged for analysis.

Bias. This study is cross-sectional and results may be subject to a non-response bias.[53] However, recruiting a large number of individuals with hypertension across

four areas of China attempted to minimize this bias.

Sample size. The sample size was based on 15 to 30 subjects per predictor in the logistic regression model.[54] Given there were 22 predictors, the final sample size was estimated at 660. The final sample size was increased to a total of 792 participants to account for a 20% attrition (n=106 participants from each community health care center).

Data analysis. All data were analyzed using SPSSv20. Univariate statistics (frequencies, percentages, and means) were used to describe the contextual factors of the sample. Bivariate associations between context and process variables were assessed using X^2 and t-tests, or Mann-Whitney U tests for non-normally distributed outcome variables.

Based on the IFSMT theory, a multivariable logistic regression model was used to examine the association between context (individual/family, condition specific), process (BP self-regulation skills & abilities [treatment management, diet management, physical exercise management, lifestyle management, risk factor management], community health centers (CHC) visits, hospitals visits and outcomes (BP control). Preliminary steps included assessing for multicollinearity using the variance inflation factor (VIF). A hierarchical approach was used to build our final model,[56] starting with Model 1 , then cumulatively adding clusters (Models 2 and 3) of variables.

In model 1, the non-modifiable context variables related to the individual /family (age, sex, marital status, education, employment, personal incomes, and health

insurance) were explored. In model 2, modifiable variables that were condition specific (BMI, WC, disease duration, comorbidities, family history, smoking and drinking status) were added to Model 1. In model 3, processes variables related to self-regulation skills and abilities (treatment management, diet management, physical exercise management, lifestyle management, risk factors management, CHC visits, and hospitals visits) were added to Model 2. Nested models were compared using the likelihood ratio test (LRT). Clusters were kept in the model if they significantly contributed to model fit based on the LRT. A two-sided p-value of $p < 0.05$ was used to establish statistical significance.

RESULTS

Twenty-nine individuals refused to participate in the interview. Of those who participated, 114 individuals were excluded due to cognitive impairment (n= 90), pregnancy (n=11), and cancer (n=13). Of 905 eligible participants, 32 were excluded because of missing or implausible (more than 50% of the responses) data (Figure 1). A total final sample of 873 individuals with hypertension (360 males, 513 females) consented to participate in the study.

- Insert Figure 1 -

Context. Demographic characteristics of participants are presented in Table 1. The mean age of participants was 65.4 ± 9.6 years. Most of the sample were female (n=513, 58.8%), married (n=757, 86.7%) and retired (n=596, 68.3%). The majority of participants had health insurance (n=839, 96.1%) and poor BP control (n= 586, 67.1%)

with 9.7± 9.0 years disease duration. Most had an abnormal BMI (n=569, 65.1%) and WC (n= 644, 73.8%). Women were older (66.0 ± 9.2 years vs. men 64.5 ± 9.9 years), less likely to have graduated from college (13.8% vs. men 20.8%), single/divorced/widowed (19.9 % vs. men 3.9%), unemployed (17.2% vs. men 12.2%) and had a lower personal income (41.5% vs. men 26.1%). Women were also more likely to have multi-morbidities (57.1% vs. men 47.2%) and have lower DBP (82.8±10.9 vs. men 86.1±10.41).

- Insert Table 1 -

Process. Self-management process variables are reported in Table 2. The lowest scores in self-management skills and abilities were in treatment management (medication adherence, routine and regular doctors' visits, self-monitoring BP) (59.54 ± 17.43), physical exercise management (60.80 ± 32.69), lifestyle management (63.47± 18.38), and diet management (70.19 ± 23.36). Scores of risk factor management were highest (86.91 ± 24.64). Women were more likely to have higher total scores of self-management skills and abilities compared to men (66.96 ± 12.25 vs. men 63.61 ± 14.28) and women had significantly higher scores on diet management (71.91 ± 22.63 vs. men 67.71 ± 24.18) and risk factor management (96.18 ± 13.12 vs. men 73.70 ± 30.53). Women also had more hospital visits compared to men (29.2% vs. men 19.4%).

- Insert Table 2 -

Outcomes. Results of the logistic regressions analyses are depicted in Table 3. All models had good fit based on the Hosmer-Lemeshow test. In Model 1, personal

income, and health insurance were significant for BP control. Participants with lower personal incomes (≤￥1500 per month vs. >￥1500 per month) increased the odds of poor BP control (OR= 1.55, 95% CI: 1.06-2.25). A higher odds (OR= 2.67, 95% CI: 1.27-5.60) of having poor BP control was observed when paired with NCMS (mainly for rural residents) compared to UEMI (mainly for urban employees). When BMI, WC, smoking, drinking, family history, disease duration and comorbidities were added into Model 2, there was a much higher odds of a lower personal income (≤￥1500 per month per month vs. >￥1500 per month) affecting poor BP control (OR= 1.61, 95% CI: 1.10- 2.36), and slightly lower odds of NCMS compared with UEMI affecting poor BP control (OR= 2.65, 95% CI: 1.26-5.60). A higher odds of having poor BP control was also observed with a longer duration of disease (OR=1.03, 95% CI: 1.01-1.04). A similar pattern was observed when treatment management, diet management, physical exercise management, lifestyle management, risk factor management, CHC visits, and hospital visits were added to Model 3. Self-management treatments reduced the odds of poor BP control in the final model (OR= 0.98, 95% CI: 0.97-0.99). All models were controlled for personal income, health insurance, disease duration.

- Insert Table 3 -

DISCUSSION

The results of this study provide insights into the self-management practices of individuals with hypertension in China. A total of 67% of individuals with

hypertension living in the community did not achieve recommended BP targets. In previous studies, poor BP control has been linked to a lower socioeconomic status.[55] [56-58] These results are similar to those found in this study, where more than one third (35.4%) of the participants had low personal incomes (≤￥1500 (US$225)/ per month vs >￥1500 (US$225)/ per month), incomes that can barely provide the essentials of living. This inequality of personal income may be directly related to the health insurance benefit packages in China.[59] Consistent with previous studies in China, patients with UEMI have benefit packages that are more likely to cover outpatient services associated with better BP control than those enrolled in NCMS (extremely limited outpatient care benefits for rural residents).[59-61] Inadequate insurance is associated with lower rates of BP control, and supported by a US national Health and Nutrition Examination Survey (NHANES).[62] Interestingly, the majority of lower personal incomes were associated with women. Women with hypertension were older, more likely to be single/divorced/widowed, have lower education, and more likely to be unemployed. Women were also much less likely to smoke or drink. These findings are consistent with several national surveys and other cross-sectional studies.[63-65] Moreover, level of education, hours of work, occupation and responsibility in caring for children has been conceptualized by others as gender-related.[39] Gender is generally defined across four dimensions including gender roles, gender identity, gender relationships and institutionalized gender.[66] Although sex did not appear to affect BP control in this study, it may be that gender has an important role in the self-management of BP. These findings would be consistent with

others who found traditional sex differences in cardiovascular disease risk factors may be partly explained by feminine personality traits. (i.e., gender).[37] Lower educated women compared with higher educated women and non-working women compared non-working men has been associated with poor blood pressure control.[67 68] The important role gender may play in BP control requires further investigation.

Results from this study also suggests longer disease duration increases the odds of having poor BP control. Women in this study were significantly older and more likely to have more than one comorbidity compared to men. More women had arthritis and back and neck problems compared to men. Biological sex influences the development of comorbid or multi-morbid disease,[69 70] such as hypertension after menopause.[32] Comorbidities among women aged 60-79 years with hypertension have been previously reported.[69 70] They increase the complexities of care for women,[71] and have been associated with poor self-care ability.[71] Low income has not only been a predictor resulting in low adherence to medication,[72] it has also been a factor associated with the development of multi-morbid disease.[73] More women in this study also lived alone with fewer supports compared to men. These findings may explain the more frequent unscheduled physician and CHC visits in women and provide important information for developing effective self-management interventions to improve BP control in men and women with hypertension in the future.

This study is one of few to compare hypertensive self-management skills in treatment, diet, physical exercise, lifestyle, and risk factors in China. Poor BP control was significantly associated with low self-management skills, especially in treatment

management (e.g., medication adherence, regularly scheduled doctors' visits, and self-monitoring of BP). This is supported by the IFSMT theory, which purports successful BP control at the individual level is related to an individual's self-management skills and their involvement in the treatment and control of their condition.[74] A lifelong adherence to prescribed anti-hypertensive medications, regular clinic visits, and self-monitoring skills have assisted other individuals to control their blood pressure.[75 76] Non-adherence to treatment management is related to a higher risk of cardiovascular morbidity and mortality.[77 78] Hypertension is an asymptomatic disease, most individuals with hypertension do not experience symptoms and may not feel it necessary to adhere to prescribed or suggested treatment regimes.[79] Moreover, medication side effects may also deter individuals from adhering to prescribed or suggested treatment regimes, especially in the elderly Chinese.[80] The perceived benefits of Chinese herbs may be more important than western antihypertensive medications for elderly Chinese who tend to be less adherent with western antihypertensive medications and believe Chinese herbs have fewer side effects.[81] Integrating traditional practices into hypertension management regimes with frequent and careful monitoring of side effects of and adjustment of medications may be warranted. Effectiveness and adherence to antihypertensive medication regimes depends on regularly scheduled visits to community health centers.[82] Regular BP monitoring also reduces hypertension,[83 84] suggesting home BP monitoring should have a primary role in long-term BP control.

The results of this study also show that women are more likely to have better

skills in diet and risk factor management. The findings are consistent with those of Choi[64] and Zhou[85] who report that women with hypertension have higher diet management skills, especially related to the daily consumption of fresh vegetables and fruits, which are thought to be protective factors associated with better BP control.[85] Men with hypertension were also more likely to drink alcohol and smoke and have poor BP control.[86] Diet and risk factor management were not significantly associated with BP control in this study. It maybe because diet management (e.g., balanced diet and salt/sodium control within 6 grams daily) is difficult for participants to conceptualize or measure or it may be because diet and risk factor management (e.g., smoking and drinking status) were self-reported responses. Fewer women reported smoking and/or drinking, had higher WC, and had higher scores on risk factor management. Again, considering gender-related characteristics in addition to traditional sex differences in the self-management of hypertension would be important in future research.

There are several limitations to the study. First, this study is cross-sectional and results may be subject to a non-response bias.[53] However, recruiting a large number of individuals with hypertension across four areas of China attempted to minimize this bias. Second, many of the context and process variables were self-reported, increasing the potential for a response bias. Third, the scale of self-management for patients with hypertension scale has not been widely used and need further psychometric testing. The strengths of the study include use of the individual and family self-management theory and incorporation of sex and gender-based analysis and interpretation.

CONCLUSION

This is one of few studies using IFSMT theory to assess how context and process variables influence self-management outcomes in individuals with hypertension. Context variables related to longer disease duration, lower income, and NCMS health insurance (inadequate outpatient care benefits for rural residents) were associated with poor control of hypertension in China. Lower cost sharing of outpatient care, increasing access to preventive care, and improving accessibility to medications and self-management strategies NCMS enrollees should be considered by Chinese health care policy makers. Moreover, sex and gender-related characteristics appear to affect BP control. Strategies to improve knowledge and provide social supports need to be investigated in future randomized controlled trials.

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Contributors XML was a major contributor in project administration, research design, organizing the fieldwork, giving advice on the manuscript writing, and supervision. ZQ and MP were major contributors in data analysis, manuscript writing and revision. ZQ, FL, XLW and JQL were involved in community nursing training in blood pressure measurement, providing patient-centered questionnaire instructions,

collecting data, and inputting results into the database. ZQ, MP, YNZ and DLW analyzed and interpreted all patient data. All authors have read and approved the final manuscript.

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Competing interests None declared.

Patient consent Obtained.

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Table 1 Characteristics of community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	n (%)	n (%)	n (%)	
Marriage Status				<0.001
Married	757 (86.7)	346 (96.1)	411 (80.1)	
Single/Divorced/Widowed	116 (13.3)	14 (3.9)	102 (19.9)	
Education				<0.001
Primary school or no	183 (21.0)	53 (14.7)	130 (25.3)	
High school	544 (62.3)	232 (64.4)	312 (60.8)	
College or higher	146 (16.7)	75 (20.8)	71 (13.8)	
Employment				<0.001
Employed	145 (16.6)	91 (25.3)	54 (10.5)	
Unemployed	132 (15.1)	44 (12.2)	88 (17.2)	
Retired	596 (68.3)	225 (62.5)	371 (72.3)	
Personal Incomes				<0.001
≤￥1500 (US$225)	307 (35.2)	94 (26.1)	213 (41.5)	
>￥1500 (US$225)	566 (64.8)	266 (73.9)	300 (58.5)	
Health Insurance				0.170
UEMI	636 (72.9)	271 (75.3)	365 (71.2)	
URMI	103 (11.8)	32 (8.9)	71 (13.8)	

NCMS	100 (11.5)	43 (11.9)	57 (11.1)	
Uninsured	34 (3.9)	14 (3.9)	20 (3.9)	
BMI				
Underweight	10 (1.1)	2 (0.6)	8 (1.6)	0.377
Normal	304 (34.8)	120 (33.3)	184 (35.9)	
Overweight	412 (47.2)	178 (49.4)	234 (45.6)	
Obese	147 (16.8)	60 (16.7)	87 (17.0)	
WC				
Normal	229 (26.2)	144 (40.0)	85 (16.6)	<0.001
Obese	644 (73.8)	216 (60.0)	428 (83.4)	
Smoking Status				<0.001
Smoking	239 (27.4)	216 (60.0)	23 (4.5)	
Non-smoking	634 (72.6)	144 (40.0)	490 (95.5)	
Drinking Status				<0.001
Drinking	196 (22.5)	176 (48.9)	20 (3.9)	
Non-drinking	677 (77.5)	184 (51.1)	493 (96.1)	
Family History				0.944
Yes	533 (61.1)	219 (60.8)	314 (61.2)	
No	340 (38.9)	141 (39.2)	199 (38.8)	
Comorbidities				
CAD	195 (22.3)	75 (20.8)	120 (23.4)	0.370
Back/Neck problem	97 (11.1)	27 (7.5)	70 (13.6)	0.004

Stroke	96 (11.0)	44 (12.2)	52 (10.1)	0.334
Diabetes	91 (10.4)	35 (9.7)	56 (10.9)	0.569
Arthritis	61 (7.0)	18 (5.0)	43 (8.4)	0.049
COPD	55 (6.3)	24 (6.7)	31 (6.0)	0.710
MI	17 (1.9)	10 (2.8)	7 (1.4)	0.141
Nephropathy	11 (1.3)	7 (1.9)	4 (0.8)	0.132
Gastrointestinal disease	10 (1.1)	5 (1.4)	5 (1.0)	0.574
0	401 (45.9)	184 (51.1)	217 (42.3)	0.010
≥1	472 (54.1)	176 (48.9)	296 (57.7)	
BP Control				0.242
Good control	287 (32.9)	110 (30.6)	177 (34.5)	
Poor control	586 (67.1)	250 (69.4)	336 (65.5)	

UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; MI, myocardial infarction；BP, blood pressure.

Table 2 Difference in self-management processes in community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	Mean (SD)	Mean (SD)	Mean (SD)	
Treatment Management	59.54 (17.43)	59.49 (18.01)	59.58 (17.02)	0.937
Diet Management	70.18 (23.36)	67.71 (24.18)	71.91 (22.63)	0.009
Physical Exercise Management	60.80 (32.69)	59.63 (33.21)	61.62 (32.33)	0.377
Lifestyle Management	63.47 (18.38)	64.92 (17.91)	62.45 (18.66)	0.051
Risk Factors Management	86.91 (24.64)	73.70 (30.53)	96.18 (13.12)	<0.001
Total Score	65.58 (13.22)	63.61 (14.28)	66.96 (12.25)	<0.001
No. of Visiting CHC (year), n (%)				0.060
0	322 (36.9)	146 (40.6)	176 (34.3)	
≥1	551 (63.1)	214 (59.4)	337 (65.7)	
No. of Visiting Hospital (year), n (%)				0.001
0	653 (74.8)	290 (80.6)	363 (70.8)	
≥1	220 (25.2)	70 (19.4)	150 (29.2)	

CHC, Community health centers.

Table 3 Logistic regression of blood pressure control among community participants with hypertension

	Model 1				Model 2				Model 3			
	OR	CI		p	OR	CI		p	OR	CI		p
Age (year)	1.00	0.98	1.02	0.979	0.99	0.98	1.01	0.561	1.00	0.98	1.02	0.639
Sex (vs. male)	0.76	0.55	1.04	0.083	0.86	0.56	1.30	0.468	0.81	0.52	1.25	0.336
Marital Status (vs. married)	1.27	0.79	2.01	0.322	1.25	0.78	2.00	0.355	1.19	0.73	1.93	0.480
Education				0.224				0.370				0.501
High school (vs. college)	1.21	0.82	1.78	0.337	1.17	0.79	1.73	0.430	1.11	0.74	1.66	0.617
Primary school (vs. college)	1.60	0.94	2.72	0.084	1.48	0.86	2.55	0.159	1.39	0.80	2.41	0.249
Employment				0.156				0.139				0.209
Unemployed (vs. employed)	0.87	0.45	1.68	0.676	0.90	0.46	1.75	0.747	0.87	0.44	1.73	0.695
Retired (vs. employed)	0.65	0.41	1.02	0.062	0.64	0.40	1.02	0.059	0.66	0.41	1.06	0.088
Personal Income (vs. >￥1500)	1.55	1.06	2.25	0.024	1.61	1.10	2.36	0.015	1.50	1.02	2.22	0.042

Health Insurance				0.076				0.084				0.187
URMI (vs. UEMI)	1.12	0.69	1.81	0.661	1.08	0.66	1.77	0.761	0.96	0.57	1.59	0.859
NCMS (vs. UEMI)	2.67	1.27	5.60	0.009	2.65	1.26	5.60	0.011	2.22	1.05	4.72	0.037
Uninsured (vs. UEMI)	1.39	0.56	3.41	0.476	1.31	0.53	3.25	0.558	1.16	0.46	2.90	0.750
BMI (kg/m^2)					1.01	0.95	1.06	0.831	1.00	0.95	1.06	0.932
WC (vs. normal)					1.11	0.75	1.66	0.596	1.10	0.73	1.65	0.648
Smoking (vs. non-smoker)					1.39	0.87	2.22	0.165	1.53	0.93	2.51	0.094
Drinking (vs. no-drinking)					1.02	0.64	1.61	0.937	0.94	0.57	1.55	0.807
Family History (vs. no)					0.85	0.62	1.16	0.298	0.90	0.65	1.23	0.505
Disease Duration (year)					1.03	1.01	1.04	0.006	1.03	1.01	1.04	0.009
Comorbidities (vs. no)					1.12	0.83	1.53	0.463	1.13	0.82	1.55	0.450
Treatment Management									0.98	0.97	0.99	0.000
Diet Management									1.00	0.99	1.01	0.628

Physical Exercise Management						1.00	0.99	1.00	0.616
Lifestyle Management						1.00	0.99	1.01	0.474
Risk Factor Management						1.00	1.00	1.01	0.395
No. of Visiting CHC (year)						1.01	0.98	1.03	0.682
No. of Visiting Hospital (year)						0.99	0.92	1.07	0.780
Chi-square	55.649	df=11		68.547	df=18	93.214	df=25		
ΔChi-square	55.649	df=11		12.898	df=7	24.668	df=7		
-2 Loglikelihood	1050.077			1037.179		1012.512			

UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CHC, community health centers.

Figure Legend

Figure 1. A flowchart of included and excluded cases.

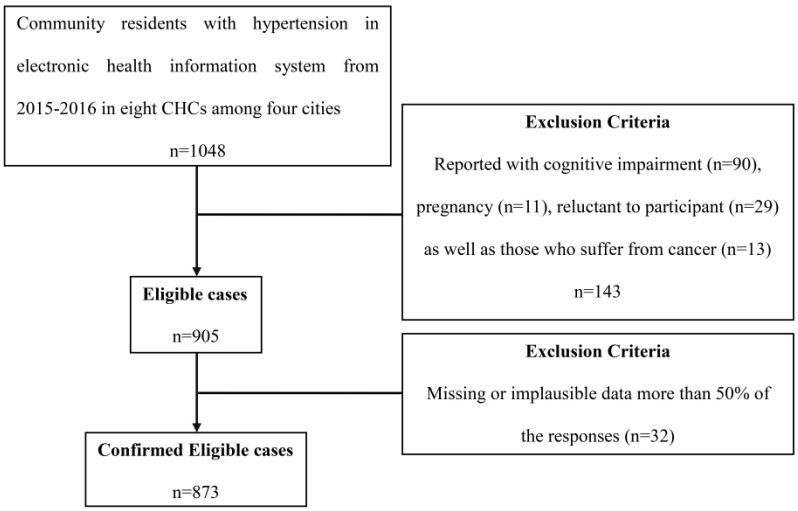

Figure 1. A flowchart of included and excluded cases.

Translation of self-management scale for patients with hypertension

Self-management Scale for Patients with Hypertension						
		Never	**Occasionally**	**Sometimes**	**Frequently (Often)**	**Always**
	Treatment Management					
1	Check your blood pressure					
2	Visiting a doctor when the blood pressure fluctuates too much					
3	Take medications as prescribed					
4	Use a method to help you remember to take your medications on time (e.g., use a pill box or other reminders)					
5	Keep doctor or nurse appointments					
6	Adjusting antihypertensive medications yourself at home based on the level of blood pressure					

7	Forget to take antihypertensive medications					
8	Buy and take antihypertensive medications from recommendation of friends or advertising					
	Diet Management					
9	Eat your meals on time and eat a balanced meal.					
10	Eat a low-salt diet (eat 6 grams or less than 6 grams of salt daily)					
	Physical Exercise Management					
11	Choose an appropriate exercise (e.g., jogging, Tai Chi, etc.)					
12	Exercise more than 3 days per week, longer than 30 minutes each time					
13	Exercise at least 30 minutes after your meal					
	Lifestyle Management					
14	Get adequate sleep					
15	Maintain a healthy bowel regime (i.e., maintain regular bowel habits					

	or normal bowel movements)					
16	Engage in social activities					
17	Try to lose weight or control body weight					
18	Keep your mood stable					
	Risk Factor Management					
19	Smoking					
20	Drinking (daily amount of alcohol intake more than 25 grams)					
21	Overstrained or excessive pressure at work					

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6-7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-10
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11-12
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	11-12
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	12
		(b) Give reasons for non-participation at each stage	12
		(c) Consider use of a flow diagram	12 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12-13 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	13-14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-18
Generalisability	21	Discuss the generalisability (external validity) of the study results	19
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	20

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Self-Management and Blood Pressure Control in China: A Community Based Multicenter Cross-Sectional Study

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ABSTRACT

Objectives This study explored the relationship between self-management and blood pressure control in China.

Design A cross-sectional study.

Setting Eight community health centers from four cities in the northeast (Shenyang), northwest (Xi'an), southwest (Chengdu), and south (Changsha) of China.

Participants A total of 873 adults with hypertension, including 360 men and 513 women. Hypertension was defined as systolic blood pressure (SBP) ⩾ 140 mmHg and/ or diastolic blood pressure (DBP) ⩾ 90 mmHg.

Outcome measurements Blood pressure control was the primary outcome variable categorized as good control if individuals with hypertension managed to reduce their blood pressure to < 140/90 mmHg, otherwise it was categorized as poor control. Secondary outcomes included self-management defined as: 1) condition specific factors and physical/social environments (context), and 2) knowledge and beliefs, self-regulation skills and abilities, and social facilitation (process). Data were analyzed using logistic regression models using SPSSv20.

Results A total of 67% (n=586) of participants had poor blood pressure control. Limited outpatient care benefits in mainly rural residents (OR=2.26, 95% CI: 1.06-4.81) and longer disease duration (OR=1.03, 95% CI: 1.01-1.04) were associated with poor blood pressure control. Self-management practices reduced the odds of having poor BP control (OR=0.98, 95% CI: 0.97-0.99).

Conclusions The individual and family self-management theory can serve as an

effective theory for understanding the key contexts, processes, and outcomes essential for blood pressure control in China. Future research should evaluate the effect of a self-management intervention (e.g., self-monitoring, medication adherence, regular and routine doctor visits, and social supports) for blood pressure control in China using a multisite cluster randomized controlled trial. Sex and gender difference, cost and patient-reported outcomes should also be examined.

Strengths and Limitations of this study

- A strength is the use of the individual and family self-management theory (IFSMT) to guide the study.
- A strength is incorporation of a sex-based analysis.
- A strength is an attempt to use a surrogate marker of gender in the interpretation of results (level of education, personal income and employment status).
- A limitation is the use of the Self-management Scale for Patients with Hypertension. It has not been widely used and need further psychometric testing.
- A limitation of the study is the use of self-reported outcomes and the potential for reporting bias.

BACKGROUND

The prevalence of hypertension has increased worldwide.[1] It is the most significant risk factor of cardiovascular disease (CVD), accounting for nearly half of the cardiovascular morbidity and mortality in the world.[2-5] In China, hypertension is a serious public health problem; it has increased almost 400% from 1980 to 2015 (from estimated 59 million to 244.5 million),[6-8] and accounted for over 2 million deaths or 24.6% of all-cause mortality.[9] Hypertensive complications in China are similar to other countries, and include stroke, myocardial infarction, heart failure and chronic kidney disease.[10] Stroke is the leading cause of death and disability in China with an annual mortality of 1.6 million;[11] hypertension is the most important risk factor for stroke with the highest attributable risk at 34.6%.[11] Annual stroke healthcare expenditures are approximately￥40 billion (US$6.4 billion), causing a huge burden to the Chinese economy.[11] Domestic and international research studies have proved that adequate control of blood pressure reduces stroke,[12] CVD[13] and burden of disease,[14 15] and significantly improves health-related quality of life (HRQOL).[16 17]

The Chinese government launched the Chinese Basic Public Health Service Program in 2009, which provides a package of care that includes hypertension and diabetes screening and management in community health facilities. In 2013, the 17-country Prospective Urban Rural Epidemiology (PURE) study reported hypertension awareness of 46.5%, treatment of 87.5%, and control of 32.5%.[2] In 2017, the China Patient-Centered Evaluative Assessment of Cardiac Events (PEACE) study of 1.7 million individuals with hypertension suggested the prevalence of hypertension in

China was 37.2%, with an awareness of 36%, treatment of 22.9%, and control of only 5.7%.[8] These results suggest current governmental packages of care are insufficient to address the burden of hypertension in China.[18]

Successful self-management strategies for individuals can result in effective control of blood pressure.[19 20] Many studies of hypertension self-management have improved blood pressure outcomes in the Western societies[15 21 22] however, the evidence for hypertension self-management is absent in the Chinese population. A recent systematic review identified only two quasi-experimental studies focusing on hypertension self-management in the population of American Chinese[23] and much of the evidence was derived from a single urban site, so is not representative of individuals living in community settings.[24 25]

The individual and family self-management theory (IFSMT) suggests a dynamic model of self-management consisting of: 1) condition specific factors and physical/social environments (context), 2) knowledge and beliefs, self-regulation skills and abilities, and social facilitation (process), and 3) cost, health status, and HRQOL (outcomes).[26] Self-regulation includes the processes used to change behavior, such as setting goals, self-monitoring, reflective thinking, planning/ participating in specific behaviors, management of responses, and self-evaluation.[26] Approaches to managing hypertension using the IFSMT within the Chronic Care Model[27 28] suggests individuals utilize self-regulation skills and abilities[19 29 30] and work in partnership with healthcare providers to improve outcomes.[31]

Sex and gender difference have been gaining attention in the development and

management of hypertension.[32-34] Women are twice as likely to have uncontrolled blood pressure after menopause,[32] have a higher prevalence of obesity,[35] and are less likely to engage in physical activities[36] compared to men. Although the treatment benefit of antihypertensive agents may not differ between men and women,[37] women with hypertension are less likely to achieve recommended blood pressure targets,[38 39] even with significantly higher use of antihypertensive medications.[39] Sex and gender are distinct concepts often used interchangeably in the literature, both are important to hypertension prevalence, awareness and management.[22 35 40] Sex represents the biological characteristics of being male or female and gender represents the social norms and expectations ascribed to men and women.[41 42] Gender differences in women's self-management practices are affected by broader social, environmental, and community factors described as gender roles, gender identity, gender relationships and institutionalized gender.[43]

The aim of this study is to describe context and process variables within the IFSMT that impact blood pressure control (outcomes) in men and women in China. This includes exploring both sex and gender aspects to self-management and blood pressure control in Chinese adults living in the community.

METHODS

Study design and settings. Using a cross-sectional study design, individuals with hypertension were recruited from eight community health care centers in the northeast (Shenyang City), northwest (Xi'an City), southwest (Chengdu City), and

south (Changsha City) of China from April 2015 to January 2016. Four geographic areas were chosen in an attempt to recruit a representative sample of individuals with hypertension in China.

Participants. Recruitment was conducted in four steps. First, forty national model community health centers accredited between 2011 and 2013 were purposely selected from the four cities in China.[44-46] These centers provide national standardized medical care to more than 100,000 individuals within a district in each of the four cities. Second, two community health care centers were randomly selected in each city from the forty national model community centers using a random number table for study participation. Third, 1048 individuals (131 from each community health center) who had been screened and diagnosed with hypertension within the past six months were randomly recruited from electronic health care information systems. Fourth, individuals were contacted to determine their interest in participating in a telephone interview to learn more about the study.

Individuals who met the following inclusion criteria were recruited to participate: age $\geqslant$ 18 years, SBP $\geqslant$ 140 mmHg and/or DBP $\geqslant$ 90 mmHg or prescribed antihypertensive medication for at least six months and able to identify their hypertensive medications within their medication schedule, able to read and write the Chinese language, and able to provide written informed consent to participate in the study. Individuals were excluded if they were pregnant, had cancer, or were cognitively impaired (defined as difficulty processing thoughts, concentrating to answer questions, or difficulty remembering the names of people and/or places they

met and/or visited recently).

The study was approved by the Ethics Committee of Xi'an Jiaotong University Health Science Center. Trained research assistants who followed standard operating procedures explained the purpose and confidentiality of the study to participants and informed consent was obtained prior to survey completion.

Patient and public involvement. Patients and the public were not involved in the design of this study.

Measurement. The IFSMT guided data collection and measurement.[26]

Context. Demographic (age, sex, marital status, education, personal income, and health insurance) data were collected by interview using investigator-developed questionnaires. Marital status was divided into two categories: married or single/divorced/widowed. Education was represented as: primary school or no formal education (< 6 years of schooling), high school (6-12 years of schooling), or college or higher (> 12 years of schooling). Personal income was divided into two categories: ≤￥1500 (US$225) or >￥1500 (US$225) based on the Chinese individual income tax rate.[47] Health insurance was divided into four categories: Urban Employees' Medical Insurance (UEMI), Urban Residents' Medical Insurance (URMI), New Rural Cooperative Medical Scheme (NCMS), or uninsured.

Risk behaviors included smoking (smoker [current smokers who smoked more than one cigarette daily]) or non-smoker [smoked fewer than 6 months and who never smoke before]) and alcohol consumption (consumer or non-consumer [consumed less than 1 glass per month and those who never drank before]). Family history of

hypertension was defined as a blood relative such as mother, father, sister, or brother with diagnosed hypertension (SBP ⩾ 140 or DBP ⩾ 90). Anthropometric measures included weight and height (body mass index [BMI]) and waist circumference [WC]). Body mass index was calculated as weight in kilograms divided by height in meters squared and classified into four levels according to the guidelines for prevention and control of overweight and obesity in Chinese adults: underweight (< 18.5 kg/m^2), normal (18.5-23.9 kg/m^2), overweight (24.0-27.9 kg/m^2), and obese: (⩾ 28 kg/m^2).[48-50] Waist circumstance (WC) was divided into two categories: obese (men ⩾ 90cm, women ⩾ 80) and normal (men < 90cm, women < 80cm) according to the International Diabetes Federation[51] and National Institute for Health and Care Excellence.[52] Comorbidities were self-reported and based on a physician's diagnosis.

Process. The self-management scale for individuals with hypertension[53] used in this study was developed by the China Medical Foundation (CMB) community chronic disease management research group. Split-half reliability of the scale was 0.976 and Cronbach's alpha ranged from 0.853 to 0.868 on each of the 5 sub-scales. The five subscales contained 21 Likert scale items addressing: treatment management, diet management, physical exercise management, lifestyle management, and risk factor management. Subscale scores ranged from 1 to 5 and total scores ranged from 21 to 105, with higher scores indicating higher self-management behaviors (Supplementary File). In this this study, we converted the original subscale scores into standard scores for comparisons.

Outcomes. *Blood Pressure*. Blood pressure control was defined as a good if individuals had a SBP < 140 mmHg and DBP < 90 mmHg. Blood pressures were taken by trained nurses using a mercury sphygmomanometer according to the criterion formulated by the Chinese Hypertension League/National Center for Cardiovascular Disease (CHL/NCCD).[54] Two BP readings for each participant were obtained at 2-minute intervals in a sitting position and then averaged for analysis.

Bias. This study is cross-sectional and results may be subject to a non-response bias.[55] However, recruiting a large number of individuals with hypertension across four areas of China attempted to minimize this bias. As this is an observational study, results are limited by self-reported survey questions. Additionally, there could be other unobserved confounding factors we have neither considered nor controlled.

Sample size. The sample size was based on 15 to 30 subjects per predictor in the logistic regression model.[56] Given there were 22 predictors, the final sample size was estimated at 660. The final sample size was increased to a total of 792 participants to account for a 20% attrition (n=106 participants from each community health care center).

Data analysis. All data were analyzed using SPSSv20. Univariate statistics (frequencies, percentages, and means) were used to describe the contextual factors of the sample. Bivariate associations between context and process variables were assessed using X^2 and t-tests, or Mann-Whitney U tests for non-normally distributed outcome variables.

Based on the IFSMT theory, a multivariable logistic regression model was used

to examine the association between context (individual/family, condition specific), process (blood pressure self-regulation skills & abilities [treatment management, diet management, physical exercise management, lifestyle management, risk factor management], community health centers (CHC) visits, hospitals visits and outcomes (blood pressure control). Preliminary steps included assessing for multicollinearity using the variance inflation factor (VIF). A hierarchical approach was used to build our final model,[56] starting with Model 1 , then cumulatively adding clusters (Models 2 and 3) of variables.

In model 1, the non-modifiable context variables related to the individual /family (age, sex, marital status, education, employment, personal incomes, and health insurance) were explored. In model 2, modifiable variables that were condition specific (BMI, WC, disease duration, comorbidities, family history, smoking and drinking status) were added to Model 1. In model 3, processes variables related to self-regulation skills and abilities (treatment management, diet management, physical exercise management, lifestyle management, risk factors management, CHC visits, and hospitals visits) were added to Model 2. Nested models were compared using the likelihood ratio test (LRT). Clusters were kept in the model if they significantly contributed to model fit based on the LRT. A two-sided p-value of $p < 0.05$ was used to establish statistical significance.

RESULTS

Twenty-nine individuals refused to participate in the interview. Of those who

participated, 114 individuals were excluded due to cognitive impairment (n= 90), pregnancy (n=11), and cancer (n=13). Of 905 eligible participants, 32 were excluded because of missing or implausible (more than 50% of the responses) data (Figure 1). A total final sample of 873 individuals with hypertension (360 males, 513 females) consented to participate in the study.

- Insert Figure 1 -

Context. Demographic characteristics of participants are presented in Table 1. The mean age of participants was 65 years. Most of the sample were female (n=513, 58.8%), married (n=757, 86.7%) and retired (n=596, 68.3%). The majority of participants had health insurance (n=839, 96.1%), 10 years disease duration and poor blood pressure control (n= 586, 67.1%). Most had an abnormal BMI (underweight, overweight and obese) (n=569, 65.1%) and WC (n= 644, 73.8%). Compared to men, more women were single/divorced/widowed, less likely to have graduated from college, were unemployed, and had a lower personal income. Women were also more likely to be non-smokers and non-drinkers but had more co-morbidities compared to men.

- Insert Table 1 -

Process. Self-management process variables are reported in Table 2. The lowest scores in self-management skills and abilities were in treatment management (e.g., medication adherence, routine and regular doctors' visits, self-monitoring blood pressure), physical exercise management, lifestyle management, and diet management. Scores of risk factor management were highest. Compared to men,

women were more likely to have higher total scores for self-management skills/abilities, diet management and risk factor management. Women also had more hospital visits compared to men.

- Insert Table 2 -

Outcomes. Results of the logistic regressions analyses are depicted in Table 3. All models had good fit based on the Hosmer-Lemeshow test. In Model 1, personal income, and health insurance were significant for BP control. Participants with NCMS (medical scheme mainly for rural residents) compared to UEMI (medical insurance mainly for urban employees) increased the odds of poor blood pressure (OR= 2.70, 95% CI: 1.28-5.67). When BMI, WC, smoking, drinking, family history, disease duration and comorbidities were added into Model 2, there was a slightly lower odds of NCMS compared with UEMI affecting poor BP control (OR= 2.69, 95% CI: 1.27-5.69). A higher odds of having poor BP control was also observed with a longer duration of disease (OR=1.03, 95% CI: 1.01-1.04). A similar pattern was observed when treatment management, diet management, physical exercise management, lifestyle management, risk factor management, CHC visits, and hospital visits were added to Model 3. Self-management treatments reduced the odds of poor BP control in the final model (OR= 0.98, 95% CI: 0.97-0.99).

- Insert Table 3 -

DISCUSSION

Context of self-management and blood pressure control. The results of this

study provide insights into the contextual self-management factors that impact blood pressure control in China. A total of 67% of individuals with hypertension living in the community did not achieve recommended blood pressure targets. Our results are consistent with previous studies that suggest poor blood pressure control is linked to a lower socioeconomic status.[57] [58-60] Individuals with UEMI health insurance and benefit packages that covered outpatient services had better blood pressure control than those individuals enrolled with NCMS (extremely limited outpatient care benefits for rural residents).[61-63] Inadequate insurance and poor blood pressure control is also supported by a US national Health and Nutrition Examination Survey (NHANES).[64]

Results from this study also suggests longer disease duration increases the odds of having poor blood pressure control. This is consistent with a cross-sectional study in Hong Kong that advanced age and longer duration of antihypertensive medication use was independently associated with poor blood pressure control.[65] The longer duration of hypertension may indicate poor adherence to self-management practices. However, in other studies elderly patients (age ≥ 65 years) with hypertension and a longer duration of antihypertensive medicine use exhibited good adherence and better blood pressure control.[66] [67] In general, blood pressure is more difficult to control with increasing age. A cross-sectional study of outpatients in the United States showed that concomitant use of more than one antihypertensive medication increases with patient age (up to age 80 years, after which it then decreases); this may have an impact on the patient's willingness or ability to comply with the overall treatment regimes.[68] More

than half of the participants in this study had more than one comorbidity, which may influence participants' medication adherence.

Women in this study were significantly older and more likely to have more than one comorbidity (arthritis and back and neck problems) compared to men. In addition to age, biological sex influences the development of comorbidities,[69 70] such as hypertension after menopause.[35] Comorbidities among women aged 60 to 79 years with hypertension have been previously reported;[69 70] they increase the complexities of care for women,[71] and have been associated with poor self-care ability.[71] Low income has not only been a predictor resulting in low adherence to medication regimes,[72] it has also been a factor associated with the development of comorbid disease.[73] More women in this study also lived alone with fewer supports compared to men. These findings may explain the more frequent unscheduled physician and CHC visits in women and provide important information for developing effective self-management interventions to improve blood pressure control in China.

Individuals in this study with lower personal incomes were women; women who were older, lived alone, had lower education, and were more likely to be unemployed. Level of education, hours of work, occupation and responsibility in caring for children has been conceptualized by others as gender-related.[74] Lower educated women compared with higher educated women and non-working women compared non-working men have been associated with poor blood pressure control;[75 76] others report traditional sex differences in cardiovascular disease risk factors are explained by feminine personality traits. (i.e., gender).[41] Neither sex nor gender affected blood

pressure control in this study, but it may be because we did not have a robust measure of gender. Gender has generally been defined across four dimensions including gender roles, gender identity, gender relationships and institutionalized gender.[43] The important role gender may play in blood pressure control requires further investigation, especially in a culture where boys are encouraged to pursue higher education and girls encouraged to work in the family home.

Process of self-management and blood pressure control. This study is one of few to compare hypertensive self-management skills in treatment, diet, physical exercise, lifestyle, and risk factors in China. Poor blood pressure control was significantly associated with low self-management skills, especially in treatment management (e.g., medication adherence, regularly scheduled doctors' visits, and self-monitoring of blood pressure). This is supported by the IFSMT theory, which purports successful blood pressure control at the individual level is related to an individual's self-management skills and their involvement in the treatment and control of their condition.[77] A lifelong adherence to prescribed anti-hypertensive medications, regular clinic visits, and self-monitoring skills have assisted other individuals to control their blood pressure.[78 79] Non-adherence to treatment management is related to a higher risk of cardiovascular morbidity and mortality.[80 81] Hypertension is an asymptomatic disease, most individuals with hypertension do not experience symptoms and may not feel it necessary to adhere to prescribed or suggested treatment regimes.[82] Moreover, medication side effects may also deter individuals from adhering to prescribed or suggested treatment regimes, especially in the elderly Chinese.[83] The perceived

benefits of Chinese herbs may be more important than western antihypertensive medications for elderly Chinese who tend to be less adherent with western antihypertensive medications and believe Chinese herbs have fewer side effects.[84] Integrating traditional practices into hypertension management regimes with frequent and careful monitoring of side effects of and adjustment of medications may be warranted. Effectiveness and adherence to antihypertensive medication regimes depends on regularly scheduled visits to community health centers.[25] Regular blood pressure monitoring also reduces hypertension,[85 86] suggesting home blood pressure monitoring should have a primary role in long-term blood pressure control in China. The results of this study also show that women are more likely to have better skills in diet and risk factor management. The findings are consistent with those of Choi[87] and Zhou[88] who report that women with hypertension have higher diet management skills, especially related to the daily consumption of fresh vegetables and fruits, which are thought to be protective factors associated with better blood pressure control.[88] Diet and risk factor management were not significantly associated with blood pressure control in this study and this maybe because diet management (e.g., balanced diet and salt/sodium control) is difficult for participants to conceptualize. This requires futher exploration in future study.

Limitations. There are several limitations to the study. First, this study is cross-sectional and results may be subject to a non-response bias.[55] However, recruiting a large number of individuals with hypertension across four areas of China attempted to minimize this bias. Second, many of the context and process variables were self-

reported, increasing the potential for a response bias. Third, the scale of self-management for patients with hypertension scale has not been widely used and need further psychometric testing. Lastly, a more robust measure of gender needs to be incorporated into future research. The strengths of the study include use of the individual and family self-management theory and the incorporation of sex and gender-based lens to guide the data analyses and interpretation.

CONCLUSION

This is one of few studies using IFSMT theory to assess how context and process variables influence self-management and blood pressure in individuals with hypertension. Context variables related to longer disease duration, lower income, and NCMS health insurance (inadequate outpatient care benefits for rural residents) were associated with poor control of hypertension in China. Lower cost sharing of outpatient care, increasing access to preventive care, and improving accessibility to medications and self-management strategies for NCMS enrollees should be considered by Chinese health care policy makers. Moreover, sex and gender-related factors, including strategies to improve self-management skills and provide social supports need to be investigated in future randomized controlled trials.

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Contributors XML was a major contributor in project administration, research design, organizing the fieldwork, giving advice on the manuscript writing, and supervision. ZQ and MP were major contributors in data analysis, manuscript writing and revision. ZQ, FL, XLW and JQL were involved in community nursing training in blood pressure measurement, providing patient-centered questionnaire instructions, collecting data, and inputting results into the database. ZQ, MP, YNZ and DLW analyzed and interpreted all patient data. All authors have read and approved the final manuscript.

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Competing interests None declared.

Patient consent Obtained.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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Table 1 Characteristics of community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	Mean (SD)/ n (%)	Mean (SD)/ n (%)	Mean (SD)/ n (%)	
Age (years)	65 (9.5)	65 (9.9)	66 (9.2)	0.075
Marriage Status				<0.001
Married	757 (86.7)	346 (96.1)	411 (80.1)	
Single/Divorced/Widowed	116 (13.3)	14 (3.9)	102 (19.9)	
Education				<0.001
Primary school or no	183 (21.0)	53 (14.7)	130 (25.3)	
High school	544 (62.3)	232 (64.4)	312 (60.8)	
College or higher	146 (16.7)	75 (20.8)	71 (13.8)	
Employment				<0.001
Employed	145 (16.6)	91 (25.3)	54 (10.5)	
Unemployed	132 (15.1)	44 (12.2)	88 (17.2)	
Retired	596 (68.3)	225 (62.5)	371 (72.3)	
Personal Incomes				<0.001
≤￥1500 (US$225)	307 (35.2)	94 (26.1)	213 (41.5)	
>￥1500 (US$225)	566 (64.8)	266 (73.9)	300 (58.5)	
Health Insurance				0.170

UEMI	636 (72.9)	271 (75.3)	365 (71.2)	
URMI	103 (11.8)	32 (8.9)	71 (13.8)	
NCMS	100 (11.5)	43 (11.9)	57 (11.1)	
Uninsured	34 (3.9)	14 (3.9)	20 (3.9)	
BMI				
Underweight	10 (1.1)	2 (0.6)	8 (1.6)	0.377
Normal	304 (34.8)	120 (33.3)	184 (35.9)	
Overweight	412 (47.2)	178 (49.4)	234 (45.6)	
Obese	147 (16.8)	60 (16.7)	87 (17.0)	
WC				
Normal	229 (26.2)	144 (40.0)	85 (16.6)	<0.001
Obese	644 (73.8)	216 (60.0)	428 (83.4)	
Smoking Status				<0.001
Smoking	239 (27.4)	216 (60.0)	23 (4.5)	
Non-smoking	634 (72.6)	144 (40.0)	490 (95.5)	
Drinking Status				<0.001
Drinking	196 (22.5)	176 (48.9)	20 (3.9)	
Non-drinking	677 (77.5)	184 (51.1)	493 (96.1)	
Family History				0.944
Yes	533 (61.1)	219 (60.8)	314 (61.2)	
No	340 (38.9)	141 (39.2)	199 (38.8)	
Disease Duration (years)	10 (9.0)	9 (7.9)	10 (9.7)	0.079

Comorbidities				
CAD	195 (22.3)	75 (20.8)	120 (23.4)	0.370
Back/Neck problem	97 (11.1)	27 (7.5)	70 (13.6)	0.004
Stroke	96 (11.0)	44 (12.2)	52 (10.1)	0.334
Diabetes	91 (10.4)	35 (9.7)	56 (10.9)	0.569
Arthritis	61 (7.0)	18 (5.0)	43 (8.4)	0.049
COPD	55 (6.3)	24 (6.7)	31 (6.0)	0.710
MI	17 (1.9)	10 (2.8)	7 (1.4)	0.141
Nephropathy	11 (1.3)	7 (1.9)	4 (0.8)	0.132
Gastrointestinal disease	10 (1.1)	5 (1.4)	5 (1.0)	0.574
0	401 (45.9)	184 (51.1)	217 (42.3)	0.010
≥1	472 (54.1)	176 (48.9)	296 (57.7)	
BP Control				0.242
Good control	287 (32.9)	110 (30.6)	177 (34.5)	
Poor control	586 (67.1)	250 (69.4)	336 (65.5)	

UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; MI, myocardial infarction； BP, blood pressure.

Table 2 Difference in self-management processes in community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	Mean (SD)	Mean (SD)	Mean (SD)	
Treatment Management	59.54 (17.43)	59.49 (18.01)	59.58 (17.02)	0.937
Diet Management	70.18 (23.36)	67.71 (24.18)	71.91 (22.63)	0.009
Physical Exercise Management	60.80 (32.69)	59.63 (33.21)	61.62 (32.33)	0.377
Lifestyle Management	63.47 (18.38)	64.92 (17.91)	62.45 (18.66)	0.051
Risk Factors Management	86.91 (24.64)	73.70 (30.53)	96.18 (13.12)	<0.001
Total Score	65.58 (13.22)	63.61 (14.28)	66.96 (12.25)	<0.001
No. of Visiting CHC (year), n (%)				0.060
0	322 (36.9)	146 (40.6)	176 (34.3)	
≥1	551 (63.1)	214 (59.4)	337 (65.7)	
No. of Visiting Hospital (year), n (%)				0.001
0	653 (74.8)	290 (80.6)	363 (70.8)	
≥1	220 (25.2)	70 (19.4)	150 (29.2)	

CHC, Community health centers.

Table 3 Logistic regression of blood pressure control among community participants with hypertension

	Model 1				Model 2				Model 3			
	OR	CI		p	OR	CI		p	OR	CI		p
Age (year)	1.00	0.98	1.02	0.965	0.99	0.98	1.01	0.545	1.00	0.98	1.02	0.600
Sex (vs. male)	0.76	0.55	1.03	0.080	0.85	0.56	1.29	0.445	0.80	0.52	1.24	0.314
Marital Status (vs. married)	1.27	0.80	2.02	0.319	1.25	0.78	2.01	0.349	1.20	0.74	1.94	0.470
Education				0.327				0.463				0.652
HS (vs. college)	1.32	0.87	1.99	0.191	1.28	0.84	1.95	0.247	1.22	0.79	1.87	0.378
PS (vs. college)	1.50	0.80	2.80	0.204	1.37	0.72	2.58	0.339	1.25	0.65	2.40	0.496
Employment				0.163				0.148				0.218
Unemployed (vs. employed)	0.84	0.44	1.64	0.617	0.87	0.44	1.70	0.673	0.84	0.42	1.66	0.611
Retired (vs. employed)	0.65	0.41	1.02	0.062	0.64	0.40	1.02	0.059	0.66	0.41	1.06	0.86
Income (vs. >￥1500)	2.54	0.78	8.33	0.123	2.68	0.80	8.93	0.109	2.41	0.71	8.12	0.157

Health Insurance				0.075				0.082				0.182
URMI (vs. UEMI)	1.13	0.69	1.84	0.624	1.10	0.67	1.79	0.717	0.97	0.58	1.63	0.920
NCMS (vs. UEMI)	2.70	1.28	5.67	0.009	2.69	1.27	5.69	0.010	2.26	1.06	4.81	0.034
Uninsured (vs. UEMI)	1.35	0.55	3.33	0.516	1.27	0.51	3.16	0.607	1.14	0.45	2.86	0.787
Education*Income				0.460				0.426				0.410
HS*Income (<￥1500)	0.53	0.15	1.84	0.319	0.52	0.15	1.84	0.312	0.54	0.15	1.92	0.338
PS*Income (<￥1500)	0.78	0.19	3.12	0.722	0.79	0.19	3.24	0.745	0.86	0.21	3.56	0.830
BMI (kg/m^2)					1.01	0.95	1.06	0.868	1.00	0.95	1.06	0.972
WC (vs. normal)					1.14	0.76	1.69	0.535	1.12	0.75	1.69	0.585
Smoking (vs. non-smoker)					1.38	0.87	2.21	0.173	1.52	0.93	2.51	0.099
Drinking (vs. no-drinking)					1.02	0.65	1.62	0.926	0.95	0.58	1.56	0.833
Family History (vs. no)					0.84	0.62	1.15	0.283	0.89	0.65	1.23	0.484
Disease Duration (years)					1.03	1.01	1.04	0.006	1.03	1.01	1.04	0.008

Comorbidities (vs. no)			1.13	0.83	1.54	0.443	1.14	0.83	1.56	0.430
Treatment Management							0.98	0.97	0.99	0.000
Diet Management							1.00	0.99	1.01	0.639
Physical Exercise Management							1.00	0.99	1.00	0.711
Lifestyle Management							1.00	0.99	1.01	0.449
Risk Factor Management							1.00	0.99	1.01	0.381
No. of Visiting CHC (year)							1.00	0.98	1.03	0.743
No. of Visiting Hospital (year)							0.99	0.92	1.07	0.800
Chi-square	57.249	df=13	70.298	df=20			95.032	df=27		
∆Chi-square	57.249	df=13	13.048	df=8			24.734	df=7		
-2 Loglikelihood	1048.476		1035.428				1010.694			

HS, high school; PS, primary school; UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CHC, community health centers.

Figure Legend

Figure 1. A flowchart of included and excluded cases.

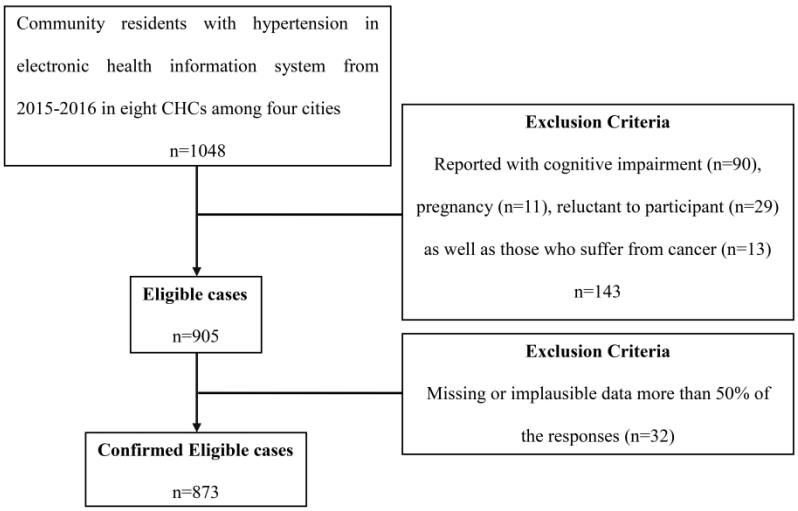

Figure 1. A flowchart of included and excluded cases.

Translation of self-management scale for patients with hypertension

Self-management Scale for Patients with Hypertension						
		Never	**Occasionally**	**Sometimes**	**Frequently (Often)**	**Always**
	Treatment Management					
1	Check your blood pressure					
2	Visiting a doctor when the blood pressure fluctuates too much					
3	Take medications as prescribed					
4	Use a method to help you remember to take your medications on time (e.g., use a pill box or other reminders)					
5	Keep doctor or nurse appointments					
6	Adjusting antihypertensive medications yourself at home based on the level of blood pressure					

7	Forget to take antihypertensive medications					
8	Buy and take antihypertensive medications from recommendation of friends or advertising					
	Diet Management					
9	Eat your meals on time and eat a balanced meal.					
10	Eat a low-salt diet (eat 6 grams or less than 6 grams of salt daily)					
	Physical Exercise Management					
11	Choose an appropriate exercise (e.g., jogging, Tai Chi, etc.)					
12	Exercise more than 3 days per week, longer than 30 minutes each time					
13	Exercise at least 30 minutes after your meal					
	Lifestyle Management					
14	Get adequate sleep					
15	Maintain a healthy bowel regime (i.e., maintain regular bowel habits					

	or normal bowel movements)					
16	Engage in social activities					
17	Try to lose weight or control body weight					
18	Keep your mood stable					
	Risk Factor Management					
19	Smoking					
20	Drinking (daily amount of alcohol intake more than 25 grams)					
21	Overstrained or excessive pressure at work					

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-10
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	11-12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-12
		(b) Give reasons for non-participation at each stage	11-12
		(c) Consider use of a flow diagram	12 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Self-Management and Blood Pressure Control in China: A Community Based Multicenter Cross-Sectional Study

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ABSTRACT

Objectives This study explored the relationship between self-management and blood pressure control in China.

Design A cross-sectional study.

Setting Eight community health centers from four cities in the northeast (Shenyang), northwest (Xi'an), southwest (Chengdu), and south (Changsha) of China.

Participants A total of 873 adults with hypertension, including 360 men and 513 women. Hypertension was defined as systolic blood pressure (SBP) ⩾ 140 mmHg and/ or diastolic blood pressure (DBP) ⩾ 90 mmHg.

Outcome measurements Blood pressure control was the primary outcome variable. This was categorized as good control if individuals with hypertension reduced their blood pressure to < 140/90 mmHg, otherwise it was categorized as poor control. Secondary outcomes included self-management, defined as: 1) context, or condition specific factors or physical/social environments (e.g., age, sex, marital status, education, personal income, and health insurance), and 2) process, or knowledge/beliefs, self-regulation skills/abilities and social facilitation (e.g., treatment, diet, exercise and risk factor management). Data were analyzed using logistic regression models using SPSSv20.

Results A total of 67% (n=586) of participants had poor blood pressure control. Limited outpatient care benefits in mainly rural residents (OR=2.26, 95% CI: 1.06-4.81) and longer disease duration (OR=1.03, 95% CI: 1.01-1.04) were associated with poor blood pressure control. Self-management practices reduced the odds of

having poor BP control (OR=0.98, 95% CI: 0.97-0.99).

Conclusions The individual and family self-management theory can serve as an effective theory for understanding the key contexts, processes, and outcomes essential for blood pressure control in China. Future research should evaluate the effect of a self-management intervention (e.g., self-monitoring, medication adherence, regular and routine doctor visits, and social supports) for blood pressure control in China using a multisite cluster randomized controlled trial. Sex and gender difference, cost and patient-reported outcomes should also be examined.

Strengths and Limitations of this study

- A strength is the use of the individual and family self-management theory (IFSMT) to guide the study.
- A strength is incorporation of a sex-based analysis.
- A strength is an attempt to use a surrogate marker of gender in the interpretation of results (level of education, personal income and employment status).
- A limitation is the use of the Self-management Scale for Patients with Hypertension. It has not been widely used and requires further psychometric testing.
- As this is a cross-sectional study, results are limited by self-reported survey questions. Additionally, there could be other unobserved confounding factors we have neither considered nor controlled.

BACKGROUND

The prevalence of hypertension has increased worldwide.[1] It is the most significant risk factor of cardiovascular disease (CVD), accounting for nearly half of the cardiovascular morbidity and mortality in the world.[2-5] In China, hypertension is a serious public health problem; it has increased almost 400% from 1980 to 2015 (from an estimated 59 million to 244.5 million)[6-8] and has accounted for over 2 million deaths or 24.6% of all-cause mortality.[9] Hypertensive complications in China are similar to other countries, which includes stroke, myocardial infarction, heart failure and chronic kidney disease.[10] Stroke is the leading cause of death and disability in China with an annual mortality of 1.6 million;[11] hypertension is the most important risk factor for stroke with the highest attributable risk at 34.6%.[11] Annual stroke healthcare expenditures are approximately ¥40 billion (US$6.4 billion), causing a huge burden to the Chinese economy.[11] Domestic and international research studies have proved that adequate control of blood pressure reduces stroke,[12] CVD[13] and burden of disease,[14 15] and significantly improves health-related quality of life (HRQOL).[16 17]

The Chinese government launched the Chinese Basic Public Health Service Program in 2009; this provides a package of care that includes hypertension and diabetes screening and management in various community health care facilities. In 2013, the 17-country Prospective Urban Rural Epidemiology (PURE) study reported hypertension awareness of 46.5%, treatment of 87.5%, and control of 32.5%.[2] In 2017, the China Patient-Centered Evaluative Assessment of Cardiac Events (PEACE) study

of 1.7 million individuals with hypertension suggested the prevalence of hypertension in China was 37.2%, with an awareness of 36%, treatment of 22.9%, and control of only 5.7%.[8] These results suggest current governmental packages of care are insufficient to address the burden of hypertension in China.[18]

Successful self-management strategies for individuals can result in effective control of blood pressure.[19 20] Many studies of hypertension self-management have improved blood pressure outcomes in the Western societies,[15 21 22] however, the evidence for hypertension self-management is absent in the Chinese population. A recent systematic review identified only two quasi-experimental studies focusing on hypertension self-management in a population of American Chinese;[23] much of the evidence was derived from a single urban site so is not representative of individuals living in community settings.[24 25]

The individual and family self-management theory (IFSMT) suggests a dynamic model of self-management consisting of: 1) condition specific factors and physical/social environments (context), 2) knowledge and beliefs, self-regulation skills and abilities, and social facilitation (process), and 3) cost, health status, and HRQOL (outcomes).[26] Self-regulation includes the processes used to change behavior, such as setting goals, self-monitoring, reflective thinking, planning/participating in specific behaviors, management of responses, and self-evaluation.[26] Approaches to managing hypertension using the IFSMT within the Chronic Care Model[27 28] suggests individuals utilize self-regulation skills and abilities[19 29 30] and work in partnership with healthcare providers to improve outcomes.[31]

Sex and gender differences have been gaining attention in the development and management of hypertension.[32-34] Women are twice as likely to have uncontrolled blood pressure after menopause,[32] have a higher prevalence of obesity,[35] and are less likely to engage in physical activities[36] compared to men. Although the treatment benefit of antihypertensive agents may not differ between men and women,[37] women with hypertension are less likely to achieve recommended blood pressure targets,[38 39] even with significantly higher use of antihypertensive medications.[39] Sex and gender are distinct concepts often used interchangeably in the literature, both are important to hypertension prevalence, awareness and management.[22 35 40] Sex represents the biological characteristics of being male or female and gender represents the social norms and expectations ascribed to men and women.[41 42] Gender differences in women's self-management practices are affected by broader social, environmental, and community factors described as gender roles, gender identity, gender relationships and institutionalized gender.[43]

The aim of this study is to describe context and process variables within the IFSMT that impact blood pressure control (outcomes) in men and women in China. This includes exploring both sex and gender aspects to self-management and blood pressure control in Chinese adults living in the community.

METHODS

Study design and settings. Using a cross-sectional study design, individuals with hypertension were recruited from eight community health care centers in the

northeast (Shenyang City), northwest (Xi'an City), southwest (Chengdu City), and south (Changsha City) of China from April 2015 to January 2016. Four geographic areas were chosen in an attempt to recruit a representative sample of individuals with hypertension in China.

Participants. Recruitment was conducted in four steps. First, forty national model community health centers accredited between 2011 and 2013 were purposely selected from the four cities in China.[44-46] These centers provide national standardized medical care to more than 100,000 individuals within a district in each of the four cities. Second, two community health care centers were randomly selected in each city from the forty national model community centers using a random number table for study participation. Third, 1048 individuals (131 from each community health center) who had been screened and diagnosed with hypertension within the past six months were randomly recruited from electronic health care information systems. Fourth, individuals were contacted to determine their interest in participating in a telephone interview to learn more about the study.

Individuals who met the following inclusion criteria were recruited to participate: age $\geqslant$ 18 years, SBP $\geqslant$ 140 mmHg and/or DBP $\geqslant$ 90 mmHg or prescribed antihypertensive medication for at least six months and able to identify their hypertensive medications within their medication schedule, able to read and write the Chinese language, and able to provide written informed consent to participate in the study. Individuals were excluded if they were pregnant, had cancer, or were identified as being cognitively impaired in the health record (< recommended cut-off score of 26

using the Montreal Cognitive Assessment [MoCA] Chinese version-Beijing version).[47]

The study was approved by the Ethics Committee of Xi'an Jiaotong University Health Science Center. Trained research assistants who followed standard operating procedures explained the purpose and confidentiality of the study to participants and informed consent was obtained prior to survey completion.

Patient and public involvement. Patients and the public were not involved in the design of this study.

Measurement. The IFSMT guided data collection and measurement.[26]

Context. Demographic (age, sex, marital status, education, personal income, and health insurance) data were collected by interview using investigator-developed questionnaires. Marital status was divided into two categories: married or single/divorced/widowed. Education was categorized as primary school or no formal education (< 6 years of schooling), high school (6-12 years of schooling), or college or higher (> 12 years of schooling). Personal income was divided into two categories: ≤￥1500 (US$225) or >￥1500 (US$225) based on Chinese individual income tax rates.[48] Health insurance was divided into four categories: Urban Employees' Medical Insurance (UEMI), Urban Residents' Medical Insurance (URMI), New Rural Cooperative Medical Scheme (NCMS), and uninsured.

Risk behaviors included smoking (smoker [current smokers who smoked more than one cigarette daily]) or non-smoker [smoked fewer than 6 months or never smoked]) and alcohol consumption (consumer or non-consumer [consumed less than

1 glass per month or never drank]). Family history of hypertension was defined as a blood relative such as mother, father, sister, or brother with diagnosed hypertension (SBP ⩾ 140 or DBP ⩾ 90). Anthropometric measures included weight and height (body mass index [BMI]) and waist circumference [WC]). Body mass index was calculated as weight in kilograms divided by height in meters squared and classified into four levels according to the guidelines for prevention and control of overweight and obesity in Chinese adults: underweight (< 18.5 kg/m^2), normal (18.5-23.9 kg/m^2), overweight (24.0-27.9 kg/m^2), and obese: (⩾28 kg/m^2).[49-51] Waist circumstance (WC) was divided into two categories: obese (men ⩾ 90cm, women ⩾ 80) and normal (men < 90cm, women < 80cm) according to the International Diabetes Federation[52] and National Institute for Health and Care Excellence.[53] Comorbidities were self-reported and based on a physician's diagnosis.

Process. The self-management scale for individuals with hypertension[54] used in this study was developed by the China Medical Foundation (CMB) community chronic disease management research group. Split-half reliability of the scale was 0.976 and Cronbach's alpha ranged from 0.853 to 0.868 on each of the 5 sub-scales. The five subscales contained 21 Likert scale items addressing: treatment management, diet management, physical exercise management, lifestyle management, and risk factor management. Subscale scores ranged from 1 to 5 and total scores ranged from 21 to 105, with higher scores indicating higher self-management behaviors (Supplementary File). In this this study, original subscale scores were converted to standard scores for comparisons.

Outcomes. *Blood Pressure*. Blood pressure control was defined as a good if individuals had a SBP < 140 mmHg and DBP < 90 mmHg. Blood pressures were taken by trained nurses using a mercury sphygmomanometer according to the criterion formulated by the Chinese Hypertension League/National Center for Cardiovascular Disease (CHL/NCCD).[55] Two BP readings for each participant were obtained at 2-minute intervals in a sitting position and then averaged for analysis.

Bias. This study is cross-sectional and results may be subject to a non-response bias.[56] However, recruiting a large number of individuals with hypertension across four areas of China attempted to minimize this bias. As this is an observational study, results are limited by self-reported survey questions. Additionally, there could be other unobserved confounding factors we have neither considered nor controlled.

Sample size. The sample size was based on 15 to 30 subjects per predictor in the logistic regression model.[57] Given there were 22 predictors, the final sample size was estimated at 660. The final sample size was increased to a total of 792 participants to account for a 20% attrition (n=106 participants from each community health care center).

Data analysis. All data were analyzed using SPSSv20. Univariate statistics (frequencies, percentages, and means) were used to describe the contextual factors of the sample. Bivariate associations between context and process variables were assessed using X^2 and t-tests, or Mann-Whitney U tests for non-normally distributed outcome variables.

Based on the IFSMT theory, a multivariable logistic regression model was used

to examine the association between context (individual/family, condition specific), process (blood pressure self-regulation skills & abilities [treatment management, diet management, physical exercise management, lifestyle management, risk factor management], community health centers (CHC) visits, hospitals visits and outcomes (blood pressure control). Preliminary steps included assessing for multicollinearity using the variance inflation factor (VIF). A hierarchical approach was used to build our final model,[56] starting with Model 1 , then cumulatively adding clusters (Models 2 and 3) of variables.

In model 1, the non-modifiable context variables related to the individual/family (age, sex, marital status, education, employment, personal incomes, and health insurance) were explored. In model 2, modifiable variables that were condition specific (BMI, WC, disease duration, comorbidities, family history, smoking and alcohol consumption) were added to Model 1. In model 3, processes variables related to self-regulation skills and abilities (treatment management, diet management, physical exercise management, lifestyle management, risk factors management, CHC visits, and hospitals visits) were added to Model 2. Nested models were compared using the likelihood ratio test (LRT). Clusters were kept in the model if they significantly contributed to model fit based on the LRT. A two-sided p-value of $p < 0.05$ was used to establish statistical significance.

RESULTS

Twenty-nine individuals refused to participate in the interview. Of those who

participated, 114 individuals were excluded due to cognitive impairment (n= 90), pregnancy (n=11), and cancer (n=13). Of 905 eligible participants, 32 were excluded because of missing or implausible (more than 50% of the responses) data (Figure 1). A total final sample of 873 individuals with hypertension (360 males, 513 females) consented to participate in the study.

- Insert Figure 1 -

Context. Demographic characteristics of participants are presented in Table 1. The mean age of participants was 65 years. Most of the sample were female (n=513, 58.8%), married (n=757, 86.7%) and retired (n=596, 68.3%). The majority of participants had health insurance (n=839, 96.1%), 10 years disease duration, and poor blood pressure control (n= 586, 67.1%). Most had an abnormal BMI (underweight, overweight and obese) (n=569, 65.1%) and WC (n= 644, 73.8%). Compared to men, more women were single/divorced/widowed, less likely to have graduated from college, were unemployed, and had a lower personal income. Women were also more likely to be non-smokers and non-drinkers but had more co-morbidities compared to men.

- Insert Table 1 -

Process. Self-management process variables are reported in Table 2. The lowest scores in self-management skills and abilities were in treatment management (e.g., medication adherence, routine and regular doctors' visits, self-monitoring blood pressure), physical exercise management, lifestyle management, and diet management. Scores of risk factor management were highest. Compared to men, women were more

likely to have higher total scores for self-management skills/abilities, diet management and risk factor management. Women also had more hospital visits compared to men.

- Insert Table 2 -

Outcomes. Results of the logistic regressions analyses are depicted in Table 3. All models had good fit based on the Hosmer-Lemeshow test. In Model 1, personal income, and health insurance were significant for BP control. Participants with NCMS (medical scheme mainly for rural residents) compared to UEMI (medical insurance mainly for urban employees) increased the odds of poor blood pressure control (OR= 2.70, 95% CI: 1.28-5.67). When BMI, WC, smoking, drinking, family history, disease duration and comorbidities were added into Model 2, there was a slightly lower odds of NCMS compared with UEMI affecting poor BP control (OR= 2.69, 95% CI: 1.27-5.69). A higher odds of having poor BP control was also observed with a longer duration of disease (OR=1.03, 95% CI: 1.01-1.04). A similar pattern was observed when treatment management, diet management, physical exercise management, lifestyle management, risk factor management, CHC visits, and hospital visits were added to Model 3. Self-management treatments reduced the odds of poor BP control in the final model (OR= 0.98, 95% CI: 0.97-0.99).

- Insert Table 3 -

DISCUSSION

Context of self-management and blood pressure control. The results of this

study provide insights into the contextual self-management factors that impact blood pressure control in China. A total of 67% of individuals with hypertension living in the community did not achieve recommended blood pressure targets. Results are consistent with previous studies that suggest poor blood pressure control is linked to a lower socioeconomic status.[58 59-61] Individuals with UEMI health insurance and benefit packages that covered outpatient services had better blood pressure control than those individuals enrolled with NCMS (extremely limited outpatient care benefits for rural residents).[62-64] Inadequate insurance and poor blood pressure control is also supported by a US national Health and Nutrition Examination Survey (NHANES).[65]

Results from this study also suggests longer disease duration increases the odds of having poor blood pressure control. This is consistent with a cross-sectional study in Hong Kong that suggested advanced age and longer duration of antihypertensive medication use was independently associated with poor blood pressure control.[66] The longer duration of hypertension may indicate poor adherence to self-management practices. However, others reported good adherence and better blood pressure control in elderly individuals (age $\geqslant$ 65 years) with hypertension and a longer duration of antihypertensive medicine use.[67 68] In general, blood pressure may be more difficult to control with increasing age. A cross-sectional study of outpatients in the United States reported that concomitant use of more than one antihypertensive medication increases with patient age (up to age 80 years, after which it then decreases); this may have an impact on the patient's willingness or ability to comply with the overall treatment

regimes.[69] More than half of the participants in this study had more than one comorbidity, which may have influenced participants' medication adherence.

Women in this study were significantly older and more likely to have more than one comorbidity (e.g., arthritis and back and neck problems) compared to men. In addition to age, biological sex influences the development of comorbidities,[70 71] such as hypertension after menopause.[35] Comorbidities among women aged 60 to 79 years with hypertension have been previously reported;[70 71] they increase the complexities of care for women,[72] and have been associated with poor self-care ability.[72] Low income has not only been a predictor resulting in low adherence to medication regimes,[73] it has also been a factor associated with the development of comorbid disease.[74] More women in this study also lived alone with fewer supports compared to men. These findings may explain the more frequent unscheduled physician and CHC visits in women and provide important information for developing effective self-management interventions to improve blood pressure control in China.

Individuals in this study with lower personal incomes were women; women who were older, lived alone, had lower education, and were more likely to be unemployed. Level of education, hours of work, occupation and responsibility in caring for children has been conceptualized by others as gender-related.[75] Lower educated women compared with higher educated women and non-working women compared non-working men have been associated with poor blood pressure control;[76 77] others report traditional sex differences in cardiovascular disease risk factors are explained by feminine personality traits. (i.e., gender).[41] Neither sex nor gender affected blood

pressure control in this study, but it may be because we did not have a robust measure of gender. Gender has generally been defined across four dimensions including gender roles, gender identity, gender relationships and institutionalized gender.[43] The important role gender may play in blood pressure control requires further investigation, especially in a culture where boys are encouraged to pursue higher education and girls encouraged to work in the family home.

Process of self-management and blood pressure control. This study is one of few to compare hypertensive self-management skills in treatment, diet, physical exercise, lifestyle, and risk factors in China. Poor blood pressure control was significantly associated with low self-management skills, especially in treatment management (e.g., medication adherence, regularly scheduled doctors' visits, and self-monitoring of blood pressure). This is supported by the IFSMT theory, which purports successful blood pressure control at the individual level is related to an individual's self-management skills and their involvement in the treatment and control of their condition.[78]A lifelong adherence to prescribed anti-hypertensive medications, regular clinic visits, and self-monitoring skills have assisted other individuals to control their blood pressure.[79 80] Non-adherence to treatment management is related to a higher risk of cardiovascular morbidity and mortality.[81 82] Hypertension is an asymptomatic disease, most individuals with hypertension do not experience symptoms and may not feel it necessary to adhere to prescribed or suggested treatment regimes.[83] Moreover, medication side effects may also deter individuals from adhering to prescribed or suggested treatment regimes, especially in the elderly

Chinese.[84] The perceived benefits of Chinese herbs may be more important than western antihypertensive medications for elderly Chinese who tend to be less adherent with western antihypertensive medications and believe Chinese herbs have fewer side effects.[85] Integrating traditional practices into hypertension management regimes with frequent and careful monitoring of side effects of and adjustment of medications may be warranted. Effectiveness and adherence to antihypertensive medication regimes depends on regularly scheduled visits to community health centers.[25] Regular blood pressure monitoring also reduces hypertension,[86 87] suggesting home blood pressure monitoring should have a primary role in long-term blood pressure control in China. The results of this study also show that women are more likely to have better skills in diet and risk factor management. The findings are consistent with those of Choi[88] and Zhou[89] who report that women with hypertension have higher diet management skills, especially related to the daily consumption of fresh vegetables and fruits, which are thought to be protective factors associated with better blood pressure control.[89] Diet and risk factor management were not significantly associated with blood pressure control in this study and this may be because diet management (e.g., balanced diet and salt/sodium control) is difficult for participants to conceptualize. This requires exploration in a future study.

Limitations. There are several limitations to the study. First, this study is cross-sectional and results may be subject to a non-response bias.[56] There could be other unobserved confounding factors we have neither considered nor controlled. However, recruiting a large number of individuals with hypertension across four areas

of China attempted to minimize this bias. Second, many of the context and process variables were self-reported, increasing the potential for a response bias. Third, the scale of self-management for patients with hypertension scale has not been widely used and need further psychometric testing. Lastly, a more robust measure of gender needs to be incorporated into future research. The strengths of the study include use of the individual and family self-management theory and the incorporation of sex and gender-based lens to guide the data analyses and interpretation.

CONCLUSION

This is one of few studies using IFSMT theory to assess how context and process variables influence self-management and blood pressure in individuals with hypertension. Context variables related to longer disease duration, lower income, and NCMS health insurance (inadequate outpatient care benefits for rural residents) were associated with poor control of hypertension in China. Lower cost sharing of outpatient care, increasing access to preventive care, and improving accessibility to medications and self-management strategies for NCMS enrollees should be considered by Chinese health care policy makers. Moreover, sex and gender-related factors, including strategies to improve self-management skills and provide social supports need to be investigated in future randomized controlled trials.

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Contributors XML was a major contributor in project administration, research design, organizing the fieldwork, giving advice on the manuscript writing, and supervision. ZQ and MP were major contributors in data analysis, manuscript writing and revision. ZQ, FL, XLW and JQL were involved in community nursing training in blood pressure measurement, providing patient-centered questionnaire instructions, collecting data, and inputting results into the database. ZQ, MP, YNZ and DLW analyzed and interpreted all patient data. All authors have read and approved the final manuscript.

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Table 1 Characteristics of community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	Mean (SD)/ n (%)	Mean (SD)/ n (%)	Mean (SD)/ n (%)	
Age (years)	65 (9.5)	65 (9.9)	66 (9.2)	0.075
Marriage Status				<0.001
Married	757 (86.7)	346 (96.1)	411 (80.1)	
Single/Divorced/Widowed	116 (13.3)	14 (3.9)	102 (19.9)	
Education				<0.001
Primary school or no	183 (21.0)	53 (14.7)	130 (25.3)	
High school	544 (62.3)	232 (64.4)	312 (60.8)	
College or higher	146 (16.7)	75 (20.8)	71 (13.8)	
Employment				<0.001
Employed	145 (16.6)	91 (25.3)	54 (10.5)	
Unemployed	132 (15.1)	44 (12.2)	88 (17.2)	
Retired	596 (68.3)	225 (62.5)	371 (72.3)	
Personal Incomes				<0.001
≤￥1500 (US$225)	307 (35.2)	94 (26.1)	213 (41.5)	
>￥1500 (US$225)	566 (64.8)	266 (73.9)	300 (58.5)	
Health Insurance				0.170
UEMI	636 (72.9)	271 (75.3)	365 (71.2)	

URMI	103 (11.8)	32 (8.9)	71 (13.8)	
NCMS	100 (11.5)	43 (11.9)	57 (11.1)	
Uninsured	34 (3.9)	14 (3.9)	20 (3.9)	
BMI				
Underweight	10 (1.1)	2 (0.6)	8 (1.6)	0.377
Normal	304 (34.8)	120 (33.3)	184 (35.9)	
Overweight	412 (47.2)	178 (49.4)	234 (45.6)	
Obese	147 (16.8)	60 (16.7)	87 (17.0)	
WC				
Normal	229 (26.2)	144 (40.0)	85 (16.6)	<0.001
Obese	644 (73.8)	216 (60.0)	428 (83.4)	
Smoking Status				<0.001
Smoking	239 (27.4)	216 (60.0)	23 (4.5)	
Non-smoking	634 (72.6)	144 (40.0)	490 (95.5)	
Drinking Status				<0.001
Drinking	196 (22.5)	176 (48.9)	20 (3.9)	
Non-drinking	677 (77.5)	184 (51.1)	493 (96.1)	
Family History				0.944
Yes	533 (61.1)	219 (60.8)	314 (61.2)	
No	340 (38.9)	141 (39.2)	199 (38.8)	
Disease Duration (years)	10 (9.0)	9 (7.9)	10 (9.7)	0.079
Comorbidities				

CAD	195 (22.3)	75 (20.8)	120 (23.4)	0.370
Back/Neck problem	97 (11.1)	27 (7.5)	70 (13.6)	0.004
Stroke	96 (11.0)	44 (12.2)	52 (10.1)	0.334
Diabetes	91 (10.4)	35 (9.7)	56 (10.9)	0.569
Arthritis	61 (7.0)	18 (5.0)	43 (8.4)	0.049
COPD	55 (6.3)	24 (6.7)	31 (6.0)	0.710
MI	17 (1.9)	10 (2.8)	7 (1.4)	0.141
Nephropathy	11 (1.3)	7 (1.9)	4 (0.8)	0.132
Gastrointestinal disease	10 (1.1)	5 (1.4)	5 (1.0)	0.574
0	401 (45.9)	184 (51.1)	217 (42.3)	0.010
≥1	472 (54.1)	176 (48.9)	296 (57.7)	
BP Control				0.242
Good control	287 (32.9)	110 (30.6)	177 (34.5)	
Poor control	586 (67.1)	250 (69.4)	336 (65.5)	

UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; MI, myocardial infarction； BP, blood pressure.

Table 2 Difference in self-management processes in community participants with hypertension

	Total (n=873)	Men (n=360)	Women (n=513)	p Value
	Mean (SD)	Mean (SD)	Mean (SD)	
Treatment Management	59.54 (17.43)	59.49 (18.01)	59.58 (17.02)	0.937
Diet Management	70.18 (23.36)	67.71 (24.18)	71.91 (22.63)	0.009
Physical Exercise Management	60.80 (32.69)	59.63 (33.21)	61.62 (32.33)	0.377
Lifestyle Management	63.47 (18.38)	64.92 (17.91)	62.45 (18.66)	0.051
Risk Factors Management	86.91 (24.64)	73.70 (30.53)	96.18 (13.12)	<0.001
Total Score	65.58 (13.22)	63.61 (14.28)	66.96 (12.25)	<0.001
No. of Visiting CHC (year), n (%)				0.060
0	322 (36.9)	146 (40.6)	176 (34.3)	
≥1	551 (63.1)	214 (59.4)	337 (65.7)	
No. of Visiting Hospital (year), n (%)				0.001
0	653 (74.8)	290 (80.6)	363 (70.8)	
≥1	220 (25.2)	70 (19.4)	150 (29.2)	

CHC, Community health centers.

Table 3 Logistic regression of blood pressure control among community participants with hypertension

	Model 1				Model 2				Model 3			
	OR	CI		p	OR	CI		p	OR	CI		p
Age (year)	1.00	0.98	1.02	0.965	0.99	0.98	1.01	0.545	1.00	0.98	1.02	0.600
Sex (vs. male)	0.76	0.55	1.03	0.080	0.85	0.56	1.29	0.445	0.80	0.52	1.24	0.314
Marital Status (vs. married)	1.27	0.80	2.02	0.319	1.25	0.78	2.01	0.349	1.20	0.74	1.94	0.470
Education				0.327				0.463				0.652
HS (vs. college)	1.32	0.87	1.99	0.191	1.28	0.84	1.95	0.247	1.22	0.79	1.87	0.378
PS (vs. college)	1.50	0.80	2.80	0.204	1.37	0.72	2.58	0.339	1.25	0.65	2.40	0.496
Employment				0.163				0.148				0.218
Unemployed (vs. employed)	0.84	0.44	1.64	0.617	0.87	0.44	1.70	0.673	0.84	0.42	1.66	0.611
Retired (vs. employed)	0.65	0.41	1.02	0.062	0.64	0.40	1.02	0.059	0.66	0.41	1.06	0.86
Income (vs. >￥1500)	2.54	0.78	8.33	0.123	2.68	0.80	8.93	0.109	2.41	0.71	8.12	0.157

Health Insurance				0.075				0.082				0.182
URMI (vs. UEMI)	1.13	0.69	1.84	0.624	1.10	0.67	1.79	0.717	0.97	0.58	1.63	0.920
NCMS (vs. UEMI)	2.70	1.28	5.67	0.009	2.69	1.27	5.69	0.010	2.26	1.06	4.81	0.034
Uninsured (vs. UEMI)	1.35	0.55	3.33	0.516	1.27	0.51	3.16	0.607	1.14	0.45	2.86	0.787
Education*Income				0.460				0.426				0.410
HS*Income (<￥1500)	0.53	0.15	1.84	0.319	0.52	0.15	1.84	0.312	0.54	0.15	1.92	0.338
PS*Income (<￥1500)	0.78	0.19	3.12	0.722	0.79	0.19	3.24	0.745	0.86	0.21	3.56	0.830
BMI (kg/m^2)					1.01	0.95	1.06	0.868	1.00	0.95	1.06	0.972
WC (vs. normal)					1.14	0.76	1.69	0.535	1.12	0.75	1.69	0.585
Smoking (vs. non-smoker)					1.38	0.87	2.21	0.173	1.52	0.93	2.51	0.099
Drinking (vs. no-drinking)					1.02	0.65	1.62	0.926	0.95	0.58	1.56	0.833
Family History (vs. no)					0.84	0.62	1.15	0.283	0.89	0.65	1.23	0.484
Disease Duration (years)					1.03	1.01	1.04	0.006	1.03	1.01	1.04	0.008

Comorbidities (vs. no)				1.13	0.83	1.54	0.443	1.14	0.83	1.56	0.430
Treatment Management								0.98	0.97	0.99	0.000
Diet Management								1.00	0.99	1.01	0.639
Physical Exercise Management								1.00	0.99	1.00	0.711
Lifestyle Management								1.00	0.99	1.01	0.449
Risk Factor Management								1.00	0.99	1.01	0.381
No. of Visiting CHC (year)								1.00	0.98	1.03	0.743
No. of Visiting Hospital (year)								0.99	0.92	1.07	0.800
Chi-square	57.249	df=13		70.298	df=20			95.032	df=27		
ΔChi-square	57.249	df=13		13.048	df=8			24.734	df=7		
-2 Loglikelihood	1048.476			1035.428				1010.694			

HS, high school; PS, primary school; UEMI, urban employees' medical insurance; URMI, urban residents' medical insurance; NCMS, new rural cooperative medical scheme; BMI, body mass index; WC, waist circumstance; CHC, community health centers.

Figure Legend

Figure 1. A flowchart of included and excluded cases.

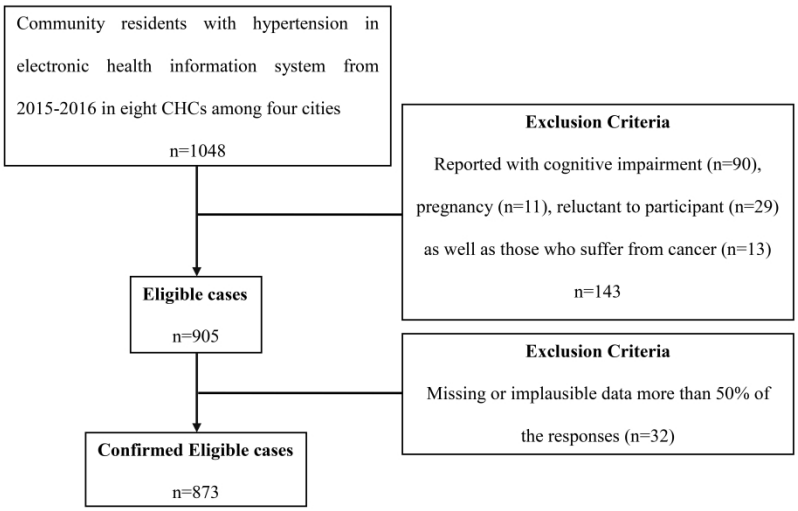

Figure 1. A flowchart of included and excluded cases.

Translation of self-management scale for patients with hypertension

Self-management Scale for Patients with Hypertension						
		Never	**Occasionally**	**Sometimes**	**Frequently (Often)**	**Always**
	Treatment Management					
1	Check your blood pressure					
2	Visiting a doctor when the blood pressure fluctuates too much					
3	Take medications as prescribed					
4	Use a method to help you remember to take your medications on time (e.g., use a pill box or other reminders)					
5	Keep doctor or nurse appointments					
6	Adjusting antihypertensive medications yourself at home based on the level of blood pressure					

7	Forget to take antihypertensive medications					
8	Buy and take antihypertensive medications from recommendation of friends or advertising					
	Diet Management					
9	Eat your meals on time and eat a balanced meal.					
10	Eat a low-salt diet (eat 6 grams or less than 6 grams of salt daily)					
	Physical Exercise Management					
11	Choose an appropriate exercise (e.g., jogging, Tai Chi, etc.)					
12	Exercise more than 3 days per week, longer than 30 minutes each time					
13	Exercise at least 30 minutes after your meal					
	Lifestyle Management					
14	Get adequate sleep					
15	Maintain a healthy bowel regime (i.e., maintain regular bowel habits					

	or normal bowel movements)					
16	Engage in social activities					
17	Try to lose weight or control body weight					
18	Keep your mood stable					
	Risk Factor Management					
19	Smoking					
20	Drinking (daily amount of alcohol intake more than 25 grams)					
21	Overstrained or excessive pressure at work					

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7-8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-10
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	10
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10-11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	11-12
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-12
		(b) Give reasons for non-participation at each stage	11-12
		(c) Consider use of a flow diagram	12 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	12 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.