ORIGINAL RESEARCH

Compliance with care and poor sleep quality among hypertensive adults in a mountainous area of Hubei Province, People's Republic of China

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Background: Little information is available concerning the relationship between compliance with hypertensive care and poor quality of sleep among Chinese adults in rural areas. This study aimed to evaluate the association between the compliance with hypertensive care and sleep quality for hypertension of adults in a mountainous area in People'sRepublic of China.

Methods: A total of 551 hypertensive patients (30–96 years of age) living in a remote mountainous area were recruited. Poor sleep quality was assessed using the standard Pittsburgh Sleep Quality Index (PSQI), and compliance with care was measured based on the Compliance of Hypertensive Patients Scale (CHPS). Hypertension was defined as blood pressure ≥140/90 mmHg or treated with antihypertensive medication. The associations between sleep quality and compliance variables were examined using Pearson's correlation. Multiple linear regressions were established to verify significant variables associated with respondents' compliance with care and poor sleep quality.

Results: The average age of the sample was 67.15 years (SD=10.20), and 56.44% of the participants were female. The mean CHPS total score was 41.97 (SD=5.91), and the PSQI total score was 7.91 on average (SD=4.10). Correlation analysis revealed that patients with higher intention, healthier lifestyle, positive attitude and total compliance were more likely to have an increased risk of poor sleep quality. According to the results of multiple linear regression analyses, hypertension compliance was significantly associated with being female, married, non-rural residence and years of hypertension, while poor sleep quality had a significant association with living in rural areas, having concomitant disease and poor hypertension compliance.

Conclusions: There is a significant association between hypertension compliance and poor sleep quality. Future intervention programs should focus on improving compliance behavior as a modifiable background factor for sleep quality.

Keywords: People's Republic of China; rural area, hypertension, compliance, poor sleep quality

Introduction

Hypertension is known as a leading risk factor of cardiovascular morbidity and mortality worldwide.[1] It has been estimated that the number of adults with hypertension will increase to 1.56 billion by 2025 and most of the cases will occur in low- and middle-income countries.[2] The risk factors of hypertension have aroused increasing attention,[3] and the major risk factors have been well established, whereas poor sleep quality is one unconventional and often overlooked risk factor.[4]

High sleep quality is necessary to maintain body function, and it can reduce the risk of cardiovascular diseases.[5] However, a previous study demonstrated that up to

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1221

40% of the elderly suffered from poor sleep initialization and maintenance.[6] According to the statistics from the Centers for Disease Control and Prevention, 11% of the adults in the United States get insufficient sleep.[7] In recent years, several prospective studies have revealed a robust relationship between sleep quality and the risk of hypertension.[8–11] Though sleep quality is of high implication,[5] studies about the relationship between poor sleep quality and negative health behaviors are surprisingly limited.[12]

Self-care is vital to chronic disease management, and both changes in behavior and lifestyle have exhibited significant reductions in blood pressure (BP). However, despite the availability of evidence-based guidelines, numerous hypertensive patients do not comply with the suggested recommendations. This is probably because many individuals with hypertension, even among patients who are aware of their condition, do not have severe symptoms to compel them to seek help, leading to poor compliance with care.[13,14] Previous studies revealed that hypertension compliance remained significantly low due to the lack of information and support, poverty, difficulty obtaining the medication and side effects of the medication, low education, and poor access to health care.[15–17] According to the World Health Organization, non-compliance for hypertension is a common issue that may lead to serious economic consequences (eg compromised health benefits and waste of money).[18] Besides, the existing studies provided the overwhelming evidence that the greatest potential for facilitating the control of BP reflected in the improvement of the compliance with care.[19–21]

Despite the risen prevalence of hypertension with poor control, the characteristic of individuals in remote mountainous areas regarding hypertension compliance behaviors and the correlation of their sleep quality have been rarely studied. Determining how hypertension compliance effect sleep quality would inform the design of more effective interventions for this population in remote mountainous areas. This study aimed to identify factors associated with the hypertension compliance and its relationship between the poor sleep quality.

Materials and methods
Ethical statement
All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional research committee and the guidelines of the Declaration of Helsinki. The present study was approved by research ethics committees of Wuhan University (2018-1602000-03-02) and the local institutional review board of Xuanen, Hubei. All participants provided written informed consent. No human or animal subjects, human cell lines or human tissues were performed.

Participants
Data for this study were extracted from a Self-Monitoring Intervention Programme for Hypertension Control in remote mountainous areas in Hubei province. In July 2018, a population-based and cross-sectional study was conducted. The program recruited participants meeting the following criteria: 1) living in the Xuanen Area, 2) aged over 18 years, 3) systolic BP≥140 mmHg and/or diastolic BP≥90 mmHg or treated with antihypertensive medication, and 4) exhibiting communication proficiency to perform study tasks. The exclusion criteria were as follows: 1) had cognitive dysfunction; and 2) too old to complete the investigation.

Procedures
Before data collection, six investigators participated in workshops conducted by Wuhan University. The investigators explained the objectives and procedures of the study to potential participants face-to-face, with unified language expression.

To consult on the implementation of the program, our research team partnered with local community leaders and township health centers personnel. We started to collect data after our study was approved by the local institutional review board. A total of 600 potential participants were identified through intensive community outreach activities in various settings (eg, village clinics, social clubs, grocery stores and house-to-house visitation). Eligible participants were given informed consent and interviewed face to face by trained research assistants. Among the 551 participants, 91.83% completed this survey.

Measurement
Assessment of sociodemographic
Participants' sociodemographic characteristics included age, gender, ethnic group, marital status, occupation, residence, years of schooling, years of hypertension, family income and concomitant disease.

Assessment of compliance
The compliance was measured based on a 14-item Compliance of Hypertensive Patients Scale (CHPS)

developed by Lahdenpera.[22] The 14 questions concerning compliance were split into the following 6 areas: Intention (4 items), Lifestyle (3 items), Attitude (3 items), Responsibility (2 items), Smoking (1 item) and Medication use (1 item). Each item is scored on a 4-point Likert scale, with 1 indicating "not at all compliance" to 4 indicating "totally compliance". Higher scores indicate higher levels of compliance. The Cronbach's Alpha was 0.69 in this sample.

Assessment of poor sleep quality

Sleep quality was assessed using the standard Pittsburgh Sleep Quality Index (PSQI) by its seven dimensions (eg, subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication and daytime dysfunction).[23] The score ranges from 0 to 21 points, with '0′ indicating no difficulty and '21′ indicating severe difficulties in all areas. Higher scores indicate higher levels of poor sleep quality. The coefficient of the PSQI ranged from 0.82 to 0.83 at different population, and acceptable reliability coefficient reached 0.77–0.85 among Chinese population.[24]

Data analysis

Demographic characteristics and scores of scales were calculated. Continuous variables are expressed as mean and standard deviation. Categorical variables are expressed as percentages. The associations between sleep quality and compliance variables were first examined using Pearson's correlation. Subsequently, multiple linear regressions were established to verify whether demographic characteristics are associated with respondents' compliance with care. In addition, the associating effect of compliance on poor sleep quality was assessed in multiple linear regressions with sleep quality as the outcome variable, and then that effect of demographic characteristics was assessed.

SPSS software version 21.0 was used to analyze the data. Values of two-sided $P<0.05$ were considered statistically significant.

Results

Characteristics of the sample

The sample characteristics are summarized in Table 1. Of the 551 subjects, 311 (56.44%) were female, with a mean age of 67.15 years (standard deviation: 10.20, range: 30–96). Over half of the participants (52.09%) ethnicity group was Tujia, followed by Han. Most of the participants (72.78%) were married and a large majority (90.02%) were farmers. Almost all (94.19%) of the participants lived in a rural area, and most

of the participants dropped out from their primary school. More than half of the participants (54.26%) reported one or more concomitant diseases, and years of hypertension ranged from <1 year to more than 10 years. The family monthly income of most of the participants (70.24%) was <2000 Yuan. The mean total score of compliance was 41.97 (SD=5.91), and the mean total PSQI was 7.91 (SD=4.10).

The correlations among key study variables

As indicated in Table 2, the results show that participants' higher intention toward hypertension, healthier lifestyle, positive attitude toward care and total compliance was significantly correlated with higher subjective sleep quality ($P<0.01$). Likewise, a stronger sense of responsibility had a significant association with lighter difficulties in sleep latency, duration and total PSQI score ($P<0.01$). Milder daytime dysfunction was significantly associated with higher intention, positive attitude and total compliance. Furthermore, participants' intention, responsibility and total compliance were negatively correlated with difficulties in total sleep quality ($P<0.05$).

Factors associated with CHPS scores

To further explore the degree of bias associated with our sample, Table 3 presents the regression results for compliance. The overall model of compliance was significant ($R^2=0.113$, $F(10, 540) =6.874$, $P<0.001$). Gender, marital status, residence and years of hypertension had a significant association with CHPS scores, while age, ethnic group, occupation, years of schooling, family income and concomitant diseases were omitted to account for the variation.

Factors associated with PSQI scores

Table 4 demonstrates the regression results for poor sleep quality scores. Residence, concomitant disease and total CHPS scores were emerged as significant association factors of PSQI score, while other variables were all omitted to account for significant variance in this model. The overall model was significant ($R^2=0.057$, $F(11, 539) =2.947$, $P=0.001$).

Discussion

Despite the high prevalence and burden on public health caused by hypertension, the factors associated with its development and progression have not been completely identified. Previous experimental and epidemiologic study[25,26] has

Table 1 Demographic characteristics of sample (N=551)

Characteristic	N (%)
Age (years)	
30–49	27 (4.90)
50–69	274 (49.73)
70–89	248 (45.01)
90–96	2 (0.36)
Mean (SD)	67.15±10.20
Gender	
Male	240 (43.56)
Female	311 (56.44)
Ethnic group	
Han	170 (30.85)
Tujia	287 (52.09)
Miao	9 (1.63)
Dong	74 (13.43)
Others	11 (2.00)
Marital status	
Married	401 (72.78)
Others	150 (27.22)
Occupation	
Farmer	496 (90.02)
Others	55 (9.98)
Residence	
Rural	519 (94.19)
Others	32 (5.81)
Years of schooling	
0	180 (32.67)
1–6	265 (48.09)
7–9	77 (13.97)
10–12	26 (4.73)
13-	3 (0.54)
Years of hypertension	
<1	68 (12.35)
1–3	115 (20.87)
4–6	127 (23.05)
7–10	50 (9.07)
>11	191 (34.66)
Concomitant disease	
Yes	299 (54.26)
No	252 (45.74)
Family income (Yuan)	
<1000	248 (45.01)

(Continued)

Table 1 (Continued).

Characteristic	N (%)
1000–1999	139 (25.23)
2000–2999	85 (15.43)
3000–3999	33 (5.99)
4000–4999	14 (2.54)
≥5000	32 (5.80)
Total CHPS (range 14–56)	41.97±5.91
Total PSQI (range 0–18)	7.91±4.10

Abbreviations: CHPS, Compliance of Hypertensive Patients Scale; PSQI, Pittsburgh Sleep Quality Index.

shown that poor sleep quality and insufficient sleep exacerbate the incidence rate of hypertension. That is, sleep quality may be an indirect factor responsible for cardiovascular damage. Understanding the effect of compliance with hypertension care on sleep quality could give an accurate insight into design of psychosocial interventions to reduce risk of poor sleep quality. This study contributes to be the first research to explore correlates of hypertension compliance with sleep quality among adults with hypertension.

We found that higher hypertension compliance pays a significant role in decreasing risk of poor sleep quality. As Ko[27] noted earlier, when faced with multiple health problems, a high level of self-efficacy may lead to successful manage care, symptoms and lifestyle adherence to living with a chronic disease condition, thus, they may maintain better physical and psychosocial consequences. Schmieder[28] also found that patients with treatment-resistant hypertension had increase stress and anxiety, and had a poor overall health condition. Sleep is an integral part of daily life, our finding, together with previous studies, underscores the importance of compliance behaviors to improve physical condition.

To date, there exists no general definition of compliance. Compared with the studies on the control of hypertension, few studies focused on the factors associated with the compliance of hypertensive patients. In this study, we adopted the conception from Lahdenpera,[22] who defined compliance as the hypertensive patients work in collaboration with the health care personnel proactively and change their lifestyle according to the recommendations. We found years of hypertension to be a significant factor in the regression model associated with compliance behavior. This is probably because years of hypertension can affect patients' attitude toward the care. The effect of an individual's hypertension awareness has a critical impact on self-care management practices and it was associated

Table 2 Correlations between patients' hypertension compliance and poor sleep quality (N=551)

Correlated factors	Subjective sleep quality	Sleep latency	Sleep duration	Sleep efficiency	Sleep disturbance	Hypnotic drugs	Daytime dysfunction	Total PSQI
Intention	−0.121**	−0.054	0.015	−0.015	−0.020	−0.064	−0.158**	−0.089*
Lifestyle	−0.178**	0.003	0.046	0.036	0.023	0.036	0.022	−0.001
Attitude	−0.171**	−0.021	−0.003	−0.001	−0.012	−0.062	−0.115**	−0.077
Responsibility	−0.052	−0.182**	−0.045	−0.163**	−0.017	−0.032	−0.066	−0.144**
Smoking	0.004	−0.020	−0.067	0.015	0.032	−0.017	0.026	−0.006
Medication use	0.033	0.044	0.040	0.037	0.078	0.004	−0.060	0.037
Total CHPS	−0.176**	−0.081	0.005	−0.036	0.013	−0.041	−0.116**	−0.099*

Notes: *$P<0.05$ (two-tailed); **$P<0.01$ (two-tailed).
Abbreviations: CHPS, Compliance of Hypertensive Patients Scale; PSQI, Pittsburgh Sleep Quality Index.

Table 3 Multiple linear regression analysis of socio-demographics with hypertension compliance of participants (N=551)

	B	SE	β	P-value
Constant	35.758	2.848		
Gender[a]	2.988	0.527	0.251	<0.001
Age	0.030	0.027	0.052	0.268
Ethnic group	0.057	0.236	0.010	0.808
Marital status[b]	1.698	0.568	0.128	0.003
Residence[c]	−2.845	1.099	−0.113	0.010
Occupation	−1.329	0.902	−0.068	0.141
Years of schooling	−0.018	0.334	−0.003	0.957
Years of hypertension[d]	0.399	0.171	0.097	0.020
Family income	0.143	0.188	0.034	0.447
Concomitant disease	0.825	0.485	0.070	0.090

Notes: [a]Gender coding: male=1, female=2; [b]Marital status coding: married=1, others =0; [c]Residence coding: rural=1, others=0; [d]Years of hypertension coding: <1=1, 1–3=2, 4–6=3, 7–10=4, >11 =5.

Table 4 Multiple linear regression analysis of socio-demographic and total CHPS with hypertension compliance of participants (N=551)

	B	SE	β	P-value
Constant	10.009	2.316		
Gender	0.664	0.388	0.080	0.088
Age	−0.012	0.019	−0.029	0.542
Ethnic group	0.224	0.169	0.056	0.184
Marital status	−0.605	0.410	−0.066	0.141
Residence[a]	1.655	0.791	0.095	0.037
Occupation	−0.805	0.647	−0.059	0.213
Years of schooling	−0.310	0.239	−0.064	0.196
Years of hypertension	0.148	0.123	0.052	0.228
Family income	0.011	0.135	0.004	0.933
Concomitant disease[b]	0.917	0.348	0.112	0.009
Total CHPS	−0.086	0.031	−0.124	0.005

Notes: [a]Residence coding: rural=1, others=0; [b]Concomitant disease coding: Yes=1, No=0.
Abbreviation: CHPS, Compliance of Hypertensive Patients Scale.

with reduced hypertensive compliance.[29] On the one hand, manifestation of symptoms promoted their hypertensive compliance. On the other hand, with the extension of disease time, some patient might feel it unnecessary to continue with care when they were feeling well. Thus, our finding implies that future studies must establish a cohort that track the relationship between years of hypertension and compliance among Chinese people.

Meanwhile, we found family income to be insignificant factors associated with hypertension compliance. This result is inconsistent with Osamor[30] who pointed out that when people feel hungry, only food matters them. Similar findings regarding socioeconomic status and its effect on hypertension compliance can also be found in other settings.[31,32] In South Africa, previous study[31] indicated that compared with people in the low socioeconomic index, those with greater economic resources were more likely to pay for all types of health services. Similar in Nigeria, a prior study by Akpa[32] reported that poor socioeconomic status had negative effect on health seeking behaviors for hypertension and compliance to treatment. Whether the lack of other variables reflecting the true relationship between family income and compliance was uncertain, or it might be the practice effects of New Rural Cooperative Medical System[33] in remote areas that made it possible for people in remote mountain district to get adequate medical resources. The result of this study, however, point to a need for a more rigorously designed sample to tease out the correlates of family income with hypertension compliance as hypothesized.

Given the impact of socio-demographic on sleep quality, our present study indicated that residence and concomitant disease were significantly associated with sleep quality among hypertensive patients. This result might be explained that our sample consisted of 94.19% people living in rural areas and 90% were farmers, they engaged in farm work in the daytime, this living environment leads to maintain the ability to develop sleep habits to the other

days' labor work. Other variables were not associated with sleep quality. However, these findings were inconsistent with other existed findings, demonstrating that gender,[34] marital status,[35] education level[36] and employment[37] were all linked to poor sleep quality. We consider that these indicators may have some potential relationship with sleep quality, which requires further studies.

Hypertensive adults living in remote mountain areas are a vulnerable group in People's Republic of China, thus studying their sleep quality is of high implication. The strength of this study is that it is the first to evaluate the relationship between compliance and sleep quality. Besides, our data are considered very reliable since it was based on face-to-face interviews instead of telephone interviews. However, several limitations of this study are noteworthy. First, the cross-sectional design cannot determine a causal relationship between self-reported compliance and sleep quality. Second, the present study did not include all background variables (eg, body mass index, smoking, alcohol consumption, chronic obstructive pulmonary disease and milder forms of exercise), which may affect sleep quality or BP as well. Third, our settings are only involved in Xuanen Country, and our results cannot be generalized to include all adults in rural areas of People's Republic of China. Furthermore, since most educated people and young people migrate to the cities to earn a living, our study population cannot represent all the general population in rural areas. Lastly, all measurements were obtained from self-report, leading to reporting bias (eg, recall error, social desirability and other types of misreporting). Future studies adopting polysomnograms are warranted. More generally, the present study only provided information about inter-individual differences in sleep quality, and further long-itudinal research is required to draw conclusions regarding the risk of poor sleep quality in a comprehensive set of domains as well as different markers and determinants during the life course of hypertensive patients.

Conclusion

Our findings suggested that a high global PSQI score is associated with poor hypertension compliance. According to our results, we found that improving the compliance to hypertensive care may be an effective intervention to improve patients' sleep quality. Subsequent research should focus more on modifiable variables (eg, compliance) as a means to improve sleep quality among hypertensive patients. Furthermore, a larger sample population that is sufficiently representative and a larger number of variables can better

enrich other factors affecting sleep quality in different residence and ethnic samples with hypertension.

Abbreviations

BP, blood pressure; PSQI, Pittsburgh Sleep Quality Index; CHPS, Compliance of Hypertensive Patients Scale.

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Author contributions

All authors contributed to investigation, data analysis, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

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