Postprint of a Study on the Impact of Lifestyle Behaviors on Quality of Life in Hypertensive Patients

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Abstract

Background Hypertension is one of the chronic diseases with relatively high prevalence in China, and its onset is showing a "younger age" trend. Unhealthy behavioral lifestyles are risk factors for hypertension, and there is an urgent need to explore the impact of behavioral lifestyles on quality of life in hypertensive populations. Objective To understand the impact of behavioral lifestyles on quality of life in hypertensive patients and to provide scientific evidence for developing effective behavioral lifestyle intervention strategies. Methods Data for this study were derived from the 2022 Psychological and Behavioral Investigation of Chinese Residents (PBICR-2022), with hypertensive patients as the study subjects (n=1,525). General characteristics and behavioral lifestyle information of the subjects were collected. Physical activity level was assessed using the International Physical Activity Questionnaire Short Form (IPAQ-7), and quality of life was evaluated using the European Five-Dimensional Five-Level Quality of Life Scale (EQ-5D-5L). Multiple linear regression and restricted cubic spline methods were employed to explore the impact of behavioral lifestyles on quality of life. Results The median EQ-5D-5L utility value for hypertensive patients was 0.951 (0.893, 1.000), and the median EQ-VAS score was 75.0 (60.0, 85.0). Multiple linear regression analysis showed that daily breakfast consumption, sleep quality, and daily sitting duration were influencing factors for both EQ-5D-5L utility value and EQ-VAS score ($P<0.05$); current sugar-sweetened beverage consumption and daily water intake were influencing factors for EQ-VAS score ($P<0.05$); weekly physical activity level was an influencing factor for EQ-5D-5L utility value ($P<0.05$). Restricted cubic spline results revealed a linear dose-response relationship between daily sitting duration and EQ-5D-5L utility value and EQ-VAS score (P for trend<0.05, P for nonlinearity>0.05), with both EQ-5D-5L utility value and EQ-VAS score decreasing as daily sitting duration increased. There was an approximately "n" -shaped nonlinear

dose-response relationship between weekly physical activity level and EQ-5D-5L utility value (P for trend<0.05, P for nonlinearity<0.05), where the EQ-5D-5L utility value initially increased and then slightly decreased with increasing weekly physical activity level, with the maximum value occurring at a weekly physical activity level of 3,750 MET-min/week. Conclusion Developing breakfast consumption habits, increasing daily water intake, cultivating good sleep habits, and reducing sugar-sweetened beverage intake contribute to improved quality of life in hypertensive patients. Daily sedentary time exceeding 4 hours, as well as insufficient or excessive physical activity, all reduce the quality of life in hypertensive patients.

Full Text

The Impact of Behavioral Lifestyle on Quality of Life in Hypertensive Patients

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Abstract

Background: Hypertension is one of the most prevalent chronic diseases in China, with its incidence showing a trend toward younger age groups. Unhealthy behavioral lifestyles are a significant risk factor for the development of hypertension. Therefore, it is crucial to investigate the impact of lifestyle behaviors on the quality of life in individuals with hypertension.

Objective: To investigate the impact of behavioral lifestyle on the quality of life in hypertensive patients and provide a scientific basis for developing effective

behavioral intervention strategies.

Methods: The data for this study were derived from the 2022 Psychological and Behavioral Investigation of Chinese Residents (PBICR-2022), with hypertensive individuals as the study population (n=1,525). General characteristics and behavioral lifestyle information of the participants were collected. Physical activity levels were assessed using the International Physical Activity Questionnaire Short Form (IPAQ-7), and quality of life was evaluated using the European Five-Dimensional Five-Level Quality of Life Scale (EQ-5D-5L). The impact of behavioral lifestyle on quality of life was analyzed using multiple linear regression and restricted cubic spline models.

Results: The median EQ-5D-5L utility value was 0.951 (0.893, 1.000), and the median EQ-VAS score was 75.0 (60.0, 85.0) in hypertensive patients. The results of multiple linear regression analyses indicated that daily breakfast consumption, sleep quality, and daily sitting duration were significant factors influencing both EQ-5D-5L utility values and EQ-VAS scores ($P<0.05$). Current consumption of sugary beverages and average daily water intake were identified as factors influencing EQ-VAS scores ($P<0.05$), while weekly physical activity level was found to be a significant factor for EQ-5D-5L utility values ($P<0.05$). The restricted cubic spline analysis revealed a linear dose-response relationship between daily sitting duration and both EQ-5D-5L utility values and EQ-VAS scores ($P_{overall\ trend}<0.05$, $P_{non-linear}>0.05$), with both utility values and EQ-VAS scores declining as daily sitting duration increased. Additionally, a near "n" -shaped nonlinear dose-response relationship was observed between weekly physical activity level and EQ-5D-5L utility values ($P_{overall\ trend}<0.05$, $P_{non-linear}<0.05$). As weekly physical activity level increased, the EQ-5D-5L utility values initially increased and then slightly decreased, with the peak occurring at a weekly physical activity level of 3,750 MET-min/week.

Conclusion: Adopting the habit of eating breakfast, increasing daily water intake, developing good sleep habits, and reducing the consumption of sugary beverages can improve the quality of life in hypertensive patients. In contrast, daily sitting duration exceeding four hours, as well as insufficient or excessive physical activity, may negatively impact the quality of life of hypertensive patients.

Keywords: Hypertension; Quality of life; Life style; EQ-5D-5L scale; Restricted cubic spline

Introduction

Hypertension is a common chronic disease characterized by persistently elevated arterial blood pressure [1] and has become one of China' s major public health challenges [2]. According to the "China Cardiovascular Disease and Health Report 2021," the prevalence of hypertension among Chinese adult residents has

reached 27.9% [3]. Common symptoms such as headache and dizziness in hypertensive patients interfere with daily life and reduce work efficiency, while serious complications like stroke and coronary heart disease can cause permanent damage [4]. As chronic diseases like hypertension are difficult to cure, traditional cure rates are inadequate for evaluating treatment outcomes. With rapid socioeconomic development and advancements in healthcare, conventional cure-rate metrics face challenges from evolving health concepts and medical models, shifting the focus of chronic disease treatment from survival time to quality of life. The growing body of research on quality of life in chronic disease populations will further advance clinical practice [5].

Quality of life refers to the measurement of health status and subjective satisfaction associated with disease, accidental injury, and medical intervention in relation to personal life events, representing a key indicator for evaluating treatment effectiveness and patient survival quality in chronic diseases [6]. Commonly used measurement tools include the 36-Item Short Form Health Survey (SF-36) and the EuroQol five-dimensional questionnaire (EQ-5D). Behavioral lifestyle factors (including smoking, alcohol consumption, diet, and physical activity) are important determinants affecting the quality of life in hypertensive patients [7]. Numerous studies have demonstrated that lifestyle modifications such as dietary improvements, increased exercise, smoking cessation, and alcohol limitation can effectively improve quality of life in hypertensive patients [8-10]. Conversely, unhealthy behavioral lifestyles, such as high-salt diets, lack of exercise, and smoking, may not only contribute to the development of hypertension but also exacerbate the condition, increase complication risks, and reduce quality of life. The "Healthy China Action (2019-2030)" emphasizes that individuals can prevent or delay the onset and progression of hypertension through healthy lifestyles (including balanced diets and appropriate physical activity) [11].

Restricted cubic spline models intuitively present the impact of subtle changes in independent variables on dependent variables through continuous curves, serving as an effective tool for exploring dose-response relationships [12]. Previous studies have primarily focused on the correlation between behavioral lifestyle and quality of life in hypertensive patients, but the dose-response relationships between physical activity levels, sedentary duration, and quality of life require further clarification. Therefore, this study employs multiple linear regression and restricted cubic spline methods to investigate the impact of behavioral lifestyle on quality of life in hypertensive patients, aiming to provide a scientific basis for developing effective behavioral intervention strategies and personalized treatment plans to improve quality of life and reduce complication risks in this population.

Methods

Study Population

The data used in this study were obtained from the 2022 Psychological and Behavioral Investigation of Chinese Residents (PBICR-2022) [13-16]. PBICR-2022 is a cross-sectional survey that employed multistage sampling to select participants from 23 provinces, 5 autonomous regions, and 4 municipalities across China between June and August 2022. The survey covered 148 cities, 202 districts/counties, 390 townships/subdistricts, and 780 communities/villages, distributing 31,449 questionnaires and collecting 30,505 valid responses (97.00% validity rate). Based on the seventh national census data, PBICR-2022 used quota sampling according to gender, age, and urban-rural distribution to ensure the sample distribution aligned with China' s population characteristics. This study included 1,525 hypertensive patients who met the inclusion criteria: (1) age $ $18 years; (2) previously diagnosed with hypertension; (3) Chinese nationality; (4) permanent Chinese resident (absent $ $1 month per year); (5) voluntary participation with informed consent; (6) completed questionnaire. Exclusion criteria were: (1) unconsciousness or mental abnormalities; (2) cognitive dysfunction. PBICR-2022 received ethical approval from the Shaanxi Health Culture Research Center (No. JKWH-2022-02) and the Second Xiangya Hospital of Central South University (No. 2022-K050), and was registered with the Chinese Clinical Trial Registry (Registration No.: ChiCTR2200061046). The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [17].

Survey Instruments

The PBICR-2022 questionnaire was designed based on previous research and literature, and was finalized after expert consultation with 38 specialists and three rounds of pilot testing before formal implementation. The questionnaire content relevant to this study included three sections: general information, behavioral lifestyle, and quality of life.

General information included gender, age, ethnicity, current employment status, highest education level, residential area type, marital status, living alone in the past three months, monthly household income per capita, and hypertension grade. Hypertension grading was defined as: Grade I (systolic blood pressure 140-159 mmHg or diastolic blood pressure 90-99 mmHg) and Grade II/III (systolic blood pressure $ $160 mmHg or diastolic blood pressure $ $100 mmHg) [18].

Behavioral lifestyle included current alcohol consumption, current smoking, current sugary beverage consumption, daily breakfast consumption, average daily water intake, sleep quality, weekly physical activity level, and daily sitting duration. Weekly physical activity level and daily sitting duration were assessed using the International Physical Activity Questionnaire Short Form (IPAQ-7). IPAQ-7 consists of 7 items covering frequency and duration of vigorous-

intensity activity, moderate-intensity activity, walking, and sedentary behavior. Metabolic equivalent (MET) values were assigned to each activity type (walking=3.3, moderate-intensity activity=4.0, vigorous-intensity activity=8.0) to calculate individual weekly physical activity levels (MET-min/week) using the formula: MET value × weekly frequency (days/week) × daily duration (minutes/day), with the three intensity levels summed [19]. The IPAQ-7 sedentary behavior item "During the last 7 days, how much time did you usually spend sitting per day?" was used to calculate daily sitting duration. Previous studies have demonstrated good reliability and validity of this scale [20], with a Cronbach' s α coefficient of 0.780 in this study [21].

Quality of life was measured using the standardized EQ-5D-5L instrument, which includes a five-dimensional health descriptive system and a visual analog scale (EQ-VAS). The five-dimensional health descriptive system comprises mobility, self-care, usual activities, pain/discomfort, and anxiety/depression dimensions, each with five levels: no problems, slight problems, moderate problems, severe problems, and unable to/extreme problems. This component is converted to a single utility value using a value set, ranging from -0.391 to 1.000, where 1.000 represents optimal quality of life, 0 represents death, and values <0 represent health states worse than death. The EQ-VAS uses a vertical visual analog scale (0-100) to record self-rated health status, where 0 represents "the best health state you can imagine" and 100 represents "the worst health state you can imagine" [22]. The EQ-VAS provides a quantitative description of overall health perception. Generally, higher EQ-5D-5L utility values and EQ-VAS scores indicate better quality of life. Previous studies have shown good reliability and validity of EQ-5D-5L [23-25], with a Cronbach' s α coefficient of 0.819 in this study.

Survey Methods and Quality Control

Surveyors were university students from various provinces who received unified training. The research team established survey sites at community health service centers or relevant health stations in the sampled communities. Surveyors recruited participants by posting posters and distributing paper or electronic recruitment notices, confirming that participants met inclusion criteria. Surveyors administered electronic questionnaires through "one-on-one," "face-to-face" interactions with the public in their assigned communities. When face-to-face surveys were not feasible, surveyors used instant messaging tools like WeChat to conduct "one-on-one" video-based "face-to-face" electronic questionnaires via platforms such as Tencent Meeting and WeChat video calls. Two trained researchers independently entered the survey data and cross-checked for accuracy, performing logical checks and excluding illogical data.

Statistical Analysis

Data were analyzed using SPSS 25.0 and R 4.0.1 statistical software. Continuous variables that did not follow a normal distribution were expressed as

median (P25, P75). Categorical data were expressed as frequencies and percentages. Mann-Whitney U tests and Kruskal-Wallis H tests were used for univariate analysis of associations between quality of life and categorical variables, while Spearman rank correlation was used for associations between quality of life and continuous variables. Variables with P<0.10 in the above analyses were included in multiple linear regression to examine the impact of general characteristics and behavioral lifestyle factors on quality of life in hypertensive patients. Restricted cubic spline models were used to analyze dose-response relationships between continuous variables identified as influencing factors in the multiple linear regression and EQ-5D-5L utility values and EQ-VAS scores. The Akaike Information Criterion (AIC) was used to select the optimal number of knots for the restricted cubic spline models. Unless otherwise specified, P<0.05 was considered statistically significant, and all tests were two-tailed.

Results

Descriptive Analysis of General Characteristics, Behavioral Lifestyle, and Quality of Life in 1,525 Hypertensive Patients

General characteristics: Among the 1,525 participants, 801 (52.52%) were male and 724 (47.48%) were female. Ages ranged from 19 to 93 years, with a median age of 64 (52, 73) years; 621 (40.72%) were <60 years and 904 (59.28%) were $ $60 years. The majority were Han ethnicity (1,393, 91.34%). Regarding employment, 926 (60.72%) were not currently employed and 599 (39.28%) were employed. Most had a high school/technical secondary school education or below (1,145, 75.08%). Residential distribution included 555 (36.39%) rural and 970 (63.61%) urban residents. The majority were married (1,305, 85.57%), while 180 (11.80%) lived alone in the past three months. Monthly household income per capita was <3,000 yuan for 694 (45.51%) and $ $3,000 yuan for 831 (54.49%). Hypertension grading showed 1,015 (66.56%) with Grade I and 510 (33.44%) with Grade II/III.

Behavioral lifestyle: Current alcohol consumption was reported by 325 (21.31%), current smoking by 299 (19.61%), and current sugary beverage consumption by 528 (34.62%). Daily breakfast consumption was reported by 1,152 (75.54%). Average daily water intake of 1,200-1,699 mL was reported by 949 (62.23%). Good sleep quality was reported by 1,216 (79.74%). The median weekly physical activity level was 2,046 (924, 3,910) MET-min/week, and the median daily sitting duration was 311.0 (200.5, 480.0) minutes.

Quality of life: The median EQ-5D-5L utility value was 0.951 (0.893, 1.000), and the median EQ-VAS score was 75.0 (60.0, 85.0). The distribution of responses for each EQ-5D-5L dimension is shown in Table 1 .

Univariate Analysis of Factors Influencing Quality of Life in Hypertensive Patients

Rank sum test results showed that in terms of general characteristics, statistically significant differences in EQ-5D-5L utility values were observed across categories of gender, age, ethnicity, current employment status, highest education level, residential area type, marital status, living alone status, and hypertension grade ($P<0.05$). Statistically significant differences in EQ-VAS scores were observed across categories of gender, age, current employment status, highest education level, residential area type, marital status, and hypertension grade ($P<0.05$).

Regarding behavioral lifestyle, statistically significant differences in EQ-5D-5L utility values were observed across categories of current alcohol consumption, daily breakfast consumption, average daily water intake, and sleep quality ($P<0.05$). Statistically significant differences in EQ-VAS scores were observed across categories of current sugary beverage consumption, daily breakfast consumption, average daily water intake, and sleep quality ($P<0.05$). These results are presented in Table 2 .

Spearman rank correlation analysis revealed that age and daily sitting duration were negatively correlated with both EQ-5D-5L utility values and EQ-VAS scores ($P<0.05$). Weekly physical activity level was positively correlated with EQ-5D-5L utility values ($P<0.05$) but not significantly correlated with EQ-VAS scores ($P>0.05$). These results are shown in Table 3 .

Multiple Linear Regression Analysis of Factors Influencing Quality of Life in Hypertensive Patients

Using EQ-5D-5L utility value as the dependent variable (entered as actual values) and variables with $P<0.10$ from univariate analysis as independent variables, multiple linear regression analysis showed that age, residential area type, marital status, hypertension grade, daily breakfast consumption, sleep quality, weekly physical activity level, and daily sitting duration were significant influencing factors of EQ-5D-5L utility values in hypertensive patients ($P<0.05$). The model' s variance inflation factor (VIF) ranged from 1.028 to 1.870, indicating no significant multicollinearity; the Durbin-Watson value was 1.998, suggesting low autocorrelation of residuals. These results are presented in Table 4 .

Using EQ-VAS score as the dependent variable (entered as actual values) and variables with $P<0.10$ from univariate analysis as independent variables, multiple linear regression analysis showed that age, residential area type, marital status, current sugary beverage consumption, daily breakfast consumption, average daily water intake, sleep quality, and daily sitting duration were significant influencing factors of EQ-VAS scores in hypertensive patients ($P<0.05$). The model' s VIF ranged from 1.028 to 1.936, indicating no significant multicollinearity; the Durbin-Watson value was 1.939, suggesting low autocorrelation of residuals. These results are presented in Table 5 .

Dose-Response Relationships Between Age, Weekly Physical Activity Level, Daily Sitting Duration and Quality of Life in Hypertensive Patients

Restricted cubic spline regression analysis revealed a non-linear dose-response relationship between age and EQ-5D-5L utility values (Poverall trend<0.001, Pnon-linear<0.001). Utility values remained stable until approximately age 57, after which they declined with increasing age, showing an approximate "n" -shaped pattern (Figure 1A [Figure 1: see original paper]). Daily sitting duration showed a linear dose-response relationship with EQ-5D-5L utility values (Poverall trend<0.001, Pnon-linear=0.084), with utility values remaining stable until approximately 4 hours of sitting, after which they declined with increasing sitting duration (Figure 1B [Figure 1: see original paper]). Weekly physical activity level demonstrated a near "n"-shaped non-linear dose-response relationship with EQ-5D-5L utility values (Poverall trend<0.001, Pnon-linear=0.001), with the highest utility value occurring at approximately 3,750 MET-min/week. Beyond this level, utility values slightly decreased with further increases in physical activity (Figure 1C [Figure 1: see original paper]).

For EQ-VAS scores, restricted cubic spline regression showed linear dose-response relationships with age and daily sitting duration. EQ-VAS scores declined with increasing age, with a steeper decline after age 60 (Poverall trend<0.001, Pnon-linear=0.367) (Figure 2A [Figure 2: see original paper]). Daily sitting duration showed a linear relationship with EQ-VAS scores without an obvious inflection point, with scores continuously decreasing as sitting duration increased (Poverall trend=0.022, Pnon-linear=0.778) (Figure 2B [Figure 2: see original paper]). No significant dose-response relationship was observed between weekly physical activity level and EQ-VAS scores (Poverall trend=0.271, Pnon-linear=0.172) (Figure 2C [Figure 2: see original paper]).

Discussion

With socioeconomic development and changes in behavioral lifestyles, hypertension has become one of the most prevalent chronic diseases and represents one of the most important risk factors for morbidity and mortality from other cardiovascular and cerebrovascular diseases, posing a serious threat to life and health [26]. Unhealthy dietary habits, smoking, alcohol consumption, and physical inactivity are important risk factors for hypertension. To explore the impact of behavioral lifestyle on quality of life in hypertensive patients, this study conducted a cross-sectional questionnaire survey based on guidelines and relevant literature, enrolling 1,525 hypertensive patients.

The median EQ-5D-5L utility value of 0.951 in this study's hypertensive patients was slightly lower than the average utility value of 0.96 reported for Chinese residents [27]. Other studies have reported average utility values of 0.84 for hypertensive patients in Chengdu [28], 0.85 in Jiangxi [29], and 0.89 among

urban residents in Shaanxi [31]. This study included hypertensive patients aged 18 and older from across the nation, and the higher utility values compared to other Chinese studies may be influenced by combined effects of age, residential area, and other factors.

General characteristics such as age, residential area type, and marital status significantly impacted both EQ-5D-5L utility values and EQ-VAS scores. Quality of life decreased with advancing age, consistent with other research findings [30]. Aging is accompanied by physiological decline, reduced self-care ability, increasing limitations in daily activities, and greater susceptibility to pain or discomfort. Combined declines in physical function and increased psychological stress contribute to reduced quality of life. Urban hypertensive patients demonstrated higher overall quality of life than rural patients, with studies showing that urban patients score higher across quality of life dimensions including mobility, usual activities, pain/discomfort, and depression/anxiety [31], possibly due to better living conditions and healthcare access in urban areas. Married hypertensive patients exhibited higher quality of life compared to unmarried, divorced, or widowed patients, consistent with multiple studies [30,32-33], likely because married patients receive greater family support and care. Hypertension grade significantly influenced EQ-5D-5L utility values, with Grade II/III patients showing significantly lower utility values than Grade I patients. Blood pressure management can be achieved through comprehensive interventions including lifestyle modifications and pharmacological treatment, enabling patients to control blood pressure, improve quality of life, and reduce complication and mortality risks based on their blood pressure status and risk level [34].

Multiple behavioral lifestyle factors influenced EQ-VAS scores and EQ-5D-5L utility values. Hypertensive patients with daily breakfast consumption and higher water intake demonstrated better quality of life, while those with sugary beverage consumption habits showed lower quality of life. Unhealthy dietary habits are major risk factors for hypertension. Regular breakfast consumption reduces the risk of hypertension and cardiovascular disease, promoting cardiovascular health [35]. Adequate water intake is essential for maintaining life and promoting health [36], with studies linking water intake to cardiovascular disease, urinary system disorders, obesity, constipation, and diabetes in older adults [37]. Sugary beverages represent a major source of added sugar intake and have been associated with various chronic diseases including hypertension, with controlled intake benefiting health [38-41]. Maintaining reasonable dietary and hydration habits is crucial for hypertension prevention and serves as an effective lifestyle intervention in comprehensive hypertension management. The "China Hypertension Health Management Standards (2019)" specifically recommend avoiding or limiting sugary beverages, reducing consumption of desserts high in refined sugar, and promoting scientific hydration with plain water or light tea [34].

Hypertensive patients with better sleep quality exhibited higher quality of life. The relationship between sleep and hypertension is complex and multifaceted.

Poor sleep quality increases sympathetic nervous system activity, activates the hypothalamic-pituitary-adrenal axis, and can further elevate blood pressure in hypertensive patients, causing physiological harm [42]. Individuals with sleep disorders are prone to anxiety, which also affects cognitive and physical function [43]. Studies have shown that short sleep duration, insomnia, and sleep disorders are associated with hypertension incidence, while improving sleep quality significantly reduces both systolic and diastolic blood pressure [44]. Ensuring adequate sleep duration is also an important factor benefiting mental health and quality of life [45]. Therefore, sleep management and improving sleep quality in hypertensive patients are beneficial for blood pressure control and quality of life improvement.

Daily sitting duration was a negative influencing factor for both EQ-VAS scores and EQ-5D-5L utility values. Quality of life declined with increasing daily sedentary time. Restricted cubic spline regression analysis revealed that quality of life decreased significantly when daily sitting duration exceeded 4 hours. The "China Hypertension Health Management Standards (2019)" indicate that regular physical activity can reduce hypertension risk, and patients can benefit from appropriate exercise and breaking up sedentary behavior to lower cardiovascular disease risk [34].

Weekly physical activity level was positively correlated with EQ-5D-5L utility values. Previous research has shown that appropriate exercise can improve abnormal lipid metabolism, enhance cardiovascular function, and increase quality of life [46-48]. Psychologically, physical activity positively influences self-reported pleasure, which significantly impacts physical and mental health [49], suggesting that appropriate physical activity improves quality of life through both physical and mental pathways. This study's restricted cubic spline analysis further revealed that quality of life in hypertensive patients did not continuously improve with increasing physical activity levels. The maximum EQ-5D-5L utility value occurred at approximately 3,750 MET-min/week, corresponding to high-intensity physical activity [19], equivalent to 2.7 hours of daily walking, 2.2 hours of daily moderate-intensity activity, or 1.1 hours of daily vigorous-intensity activity. Beyond this level, utility values slightly decreased. Excessive exercise beyond one' s physical capacity or exercise habits can cause fatigue and weakness, potentially leading to muscle injury [50]. For older individuals or those with underlying conditions, prolonged moderate-to-high-intensity exercise may increase the risk of serious cardiovascular events such as myocardial infarction or sudden cardiac death [51], requiring particular attention in hypertensive patients. Additionally, long-term excessive exercise may affect exercise adherence and negatively impact mental health. Excessive physical activity does not further improve quality of life in hypertensive patients and may instead reduce it.

Developing healthy behavioral lifestyles is an effective measure for controlling blood pressure, reducing complication risks, and improving quality of life in hypertensive populations. Adopting breakfast consumption habits, increasing

daily water intake, developing good sleep habits, and reducing sugary beverage intake can improve quality of life in hypertensive patients. Conversely, daily sitting duration exceeding 4 hours, as well as insufficient or excessive physical activity, can negatively impact quality of life.

This study has several strengths. First, it is based on a nationwide quality of life study with a large sample size and broad coverage. Second, while behavioral lifestyle is crucial for regulating quality of life in chronic disease patients including those with hypertension, previous quality of life studies have primarily focused on elderly populations and examined relatively limited influencing factors. This study investigated the impact of various behavioral lifestyle factors on quality of life in adult hypertensive patients. Third, building upon linear regression, this study used restricted cubic splines to further explore dose-response relationships, providing a scientific basis for developing effective behavioral lifestyle intervention strategies and personalized treatment plans for hypertensive patients.

This study also has limitations. First, as a cross-sectional survey, it cannot establish causal relationships between variables. Second, the questionnaire relied on participants' self-recall, which may introduce recall bias. Third, although this study explored the impact of behavioral lifestyle on quality of life, it did not investigate the influence of dietary patterns, specific food intake, or detailed exercise types, which warrant further research.

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