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Association between sleep quality and blood pressure control among hypertensive patients at a rural tertiary hospital in Southern Nigeria: a cross-sectional study

Tijani Idris Ahmad Oseni [ORCID] ,[1,2] Ndifreke Ekpo Udonwa,[3] Afiong Oboko Oku,[4] Moyosore Taiwo Makinde,[5] Felix Archibong[6]

Correspondence to
Dr Tijani Idris Ahmad Oseni; oseni.tijani@edouniversity.edu.ng

ABSTRACT

Objectives Restorative sleep is critical in preventing hypertension and other chronic diseases. Limited research has explored the relationship between sleep quality and hypertension in Africa. This study investigated the association between sleep quality and blood pressure control among hypertensive patients in Southern Nigeria.

Design Cross-sectional study.

Setting A rural tertiary hospital in Southern Nigeria, April to June 2023.

Participants 250 systematically selected hypertensive adults. Participants completed a validated semistructured interviewer-administered questionnaire to assess their sleep patterns, including sleep duration, self-reported trouble sleeping and a history of clinical diagnosis of sleep disorders. Sleep patterns were categorised as restorative (healthy) or non-restorative (unhealthy). The blood pressure of respondents was checked and categorised as controlled (<140/90 mm Hg) or uncontrolled (≥140/90 mm Hg). Data were analysed descriptively using SPSS V.24.0

Outcome measures Quality of sleep and blood pressure control.

Results Respondents had a mean age of 51.5±10.0 years, with the majority being female (156, 62.4%), married (135, 54.0%) and belonging to the Esan tribe (125, 50.0%). The prevalence of restorative sleep was 36%, while the blood pressure control rate was 23.6%. An association was found between restorative sleep and blood pressure control (adjusted OR =4.38; 95% CI=2.37–8.10; p<0.0001). Respondents aged ≥60 years had 3.5 times higher odds of experiencing non-restorative sleep than those aged ≤40 years (aOR=3.46; 95% CI=1.37–8.74; p=0.009).

Conclusion The study found an association between poor quality sleep and poor blood pressure control. Incorporating sleep assessments and interventions into comprehensive hypertension management strategies could be explored as a possible approach to improve sleep quality and enhance blood pressure control.

Trial registration number PACTR202301917477205.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Sleep quality was determined based on the combined impact of sleep duration, troubled sleep and sleep disorders, unlike most previous studies that considered sleep duration alone.

⇒ The cross-sectional nature of the study design limits the establishment of causal relationships.

⇒ The reliance on self-reported sleep quality may introduce recall bias and misclassification.

INTRODUCTION

Hypertension is a major risk factor for cardiovascular diseases, accounting for half of all cases of heart failure globally.[1–3] Hypertension is a growing concern in Nigeria and globally with a global prevalence of 31.1% according to WHO and a national prevalence of 30.6% according to a systematic review and meta-analysis conducted in 2021.[1 4] Hypertension leads to adverse cardiovascular events such as stroke, heart failure, acute myocardial infarction and chronic kidney disease.[5 6] These complications are associated with significant mortality and morbidity including severe disability. There is therefore the need to identify measures that will help control blood pressure as well as increase research into low-cost measures of blood pressure (BP) control considering the poverty level in Nigeria and other low-income and middle-income countries.

Behavioural modification through lifestyle intervention, such as a healthy diet and physical activity, is recommended as a primary and adjunct treatment for hypertension.[7 8] However, the role of sleep quality in hypertension prevention and management has gained increasing attention.

Restorative sleep, typically defined as 7–9 hours of sleep per night, is essential for maintaining overall health and preventing chronic diseases, including hypertension.[9] Both short sleep duration (less than 7 hours) and long sleep duration (more than 9 hours) have been associated with adverse health outcomes, including cardiovascular diseases and diabetes.[10] Troubled sleep and sleep disorders, such as insomnia and obstructive sleep apnoea, have also been linked to an increased risk of hypertension.[11 12]

Sleep deprivation has been associated with increased sympathetic activity and reduced parasympathetic activation during sleep. These disturbances in autonomic balance are associated with hypertension.[13] There is also an association between poor sleep with weight gain and obesity leading to a higher incidence of metabolic syndrome and type 2 diabetes.[14] Patients with metabolic syndrome and diabetes in turn have a high risk (up to twofold) of developing hypertension.[15] Sleep deprivation is associated with decreased leptin and increased ghrelin leading to increased appetite and hunger with increased cravings for unhealthy snacks and sweet food/drinks. This leads to an increased risk of obesity, atherosclerosis and hypertension.[15]

While individual studies have explored the association between hypertension and abnormal sleep patterns, few have examined the combined impact of sleep duration, troubled sleep and sleep disorders. Additionally, limited research has been conducted in Africa to investigate the relationship between sleep quality and hypertension.[16 17] Therefore, this study aims to fill these gaps in knowledge by examining the association between sleep quality and blood pressure control among hypertensive patients in a rural setting in Nigeria.

METHODS
Study design and participants
We conducted a cross-sectional study between April and June 2023 among 250 adults aged 18 to 65 with hypertension who attended the Family Medicine Clinics of Irrua Specialist Teaching Hospital (ISTH), a tertiary hospital in a rural community in Edo State, Southern Nigeria. Participants were either on antihypertensive medications or recently diagnosed with hypertension. Exclusion criteria included cognitive impairment, secondary hypertension and pregnancy.

Sample size determination and sampling technique
The sample size was determined to be 303 using Fischer's formula ($N=z^2 pq/d^2$, where N is the desired sample size for a study population greater than 10 000; z=the standard normal deviation, at 95% CI, usually set at 1.96; p=prevalence of poor-quality sleep. We used 27.3% of the prevalence of insomnia among patients in a Nigerian Family Practice population[18] (q=1-p = 1–0.27=0.73 d = degree of accuracy desired, usually set at 0.05).

A systematic sampling technique was used to select participants. The Family Medicine Clinics of ISTH attends to an average of 400 patients with hypertension monthly. The sampling interval was calculated by dividing the population of the study (400 patients monthly for the 3 months (April to June 2023) the study lasted=1200) by the calculated sample size=1200/303=3.96≈4. A sampling interval of 1:4 was used as it gave all eligible subjects equal chances of being selected within the period of study. The first patient was selected from the first three patients with hypertension by simple random sampling; subsequently, every fourth patient was selected. If, however, the prospective participant to be selected was not eligible or refused to participate, the next eligible participant was then selected. This process was continued until the required sample size of 303 was achieved.

Patient and public involvement
Patients with hypertension who had sleep problems were involved in setting the research question, design and implementation of the intervention. Formal meetings were held with the patients to determine their views on the topic, whether they will be interested in participating and how findings could be disseminated to them. The interaction with such patients and other public members informed the decision to conduct this study to test for the association between sleep quality and blood pressure control. The patients and the public, particularly those in the study environment, were also involved in the dissemination of the research findings as the findings were made available to them through direct engagements during clinical consultations and through health talk to the public through formal gatherings and print and electronic media including social media platforms like Facebook and LinkedIn.

Data collection and measures
Participants completed a validated semistructured interviewer-administered questionnaire adapted from the National Health and Nutrition Examination Survey (NHANES) study by Li et al,[10] which collected information on sociodemographic characteristics, sleep duration, self-reported trouble sleeping, history of clinical diagnosis of sleep disorders and blood pressure measurements. The instrument was validated by sending a draft of it to experts in the fields of lifestyle medicine, cardiology and public health for evaluation. Content and construct validity were also assessed to ensure all areas were covered. All necessary corrections, modifications and suggestions were incorporated into the instrument before it was administered to 20 hypertensive patients and the data were analysed and subjected to Cronbach's alpha coefficient analysis to determine the internal consistency and reliability of the questionnaire; a value of 0.85 was obtained.

Sleep patterns
Sleep pattern was assessed using a standardised sleep questionnaire adapted from the NHANES study.[10] Assessment

of sleep duration was through self-report of the number of hours of sleep per day. Sleep duration was categorised into short (<7 hours per night), normal (7–9 hours per night) and long (≥9 hours per night).[10] Patients' self-reported trouble sleeping was also assessed as well as history of clinical diagnosis of sleeping disorder. Normal sleep duration (7–9 hours per night), no trouble sleeping and no previous medical diagnosis of sleep disorder were each assigned a score of 1. In comparison, abnormal sleep duration (<7 or >9 hours per night), trouble sleeping and previous diagnosis of sleep disorder were given a score of 0. The scores were summed and a total score of 0 to 1 was categorised as 'poor sleep', a total score of 2 as 'intermediate sleep' and a total score of 3 as 'restorative (healthy) sleep'.[10] Thus, patients who slept for 7–9 hours per night, had no trouble sleeping and had no previous diagnosis of sleep disorder were given the maximum score of 3 and categorised as having restorative (healthy) sleep, while others were categorised as having poor (non-restorative) sleep.

Blood pressure measurement

Blood pressure was measured using Omron Intellisense electronic sphygmomanometer, with the cuff properly applied to the left arm and with the patient sitting in a relaxed position and the BP measurement was taken at the level of the heart. Three BP measurements were taken 10 min apart and the mean of the last two measurements was recorded as the patient's BP. Controlled blood pressure was defined as systolic blood pressure <140 mm Hg and diastolic blood pressure <90 mm Hg.[19 20]

Statistical analysis

Data were analysed using SPSS V.24.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as mean±SD. χ^2 tests were used to assess the association between sleep patterns and blood pressure control. Logistic regression was performed to adjust for sociodemographic variables, and significance was set at $p<0.05$.

RESULTS

A total of 356 hypertensive patients were screened for participation in the study, out of whom, 37 did not meet the eligibility criteria and 16 declined to participate, leaving 303 who met the eligibility criteria and agreed to participate (figure 1). However, from among the 303 agreed participants, 53 questionnaires were improperly completed and thus excluded from the analysis, leaving 250 participants for inclusion in the analysis (effective response rate: 250/319 eligible participants=78.4%).

Sociodemographic characteristics

Participants had a mean age of 51.5±10.0 years, with the majority being females (156, 62.4%), married (135,
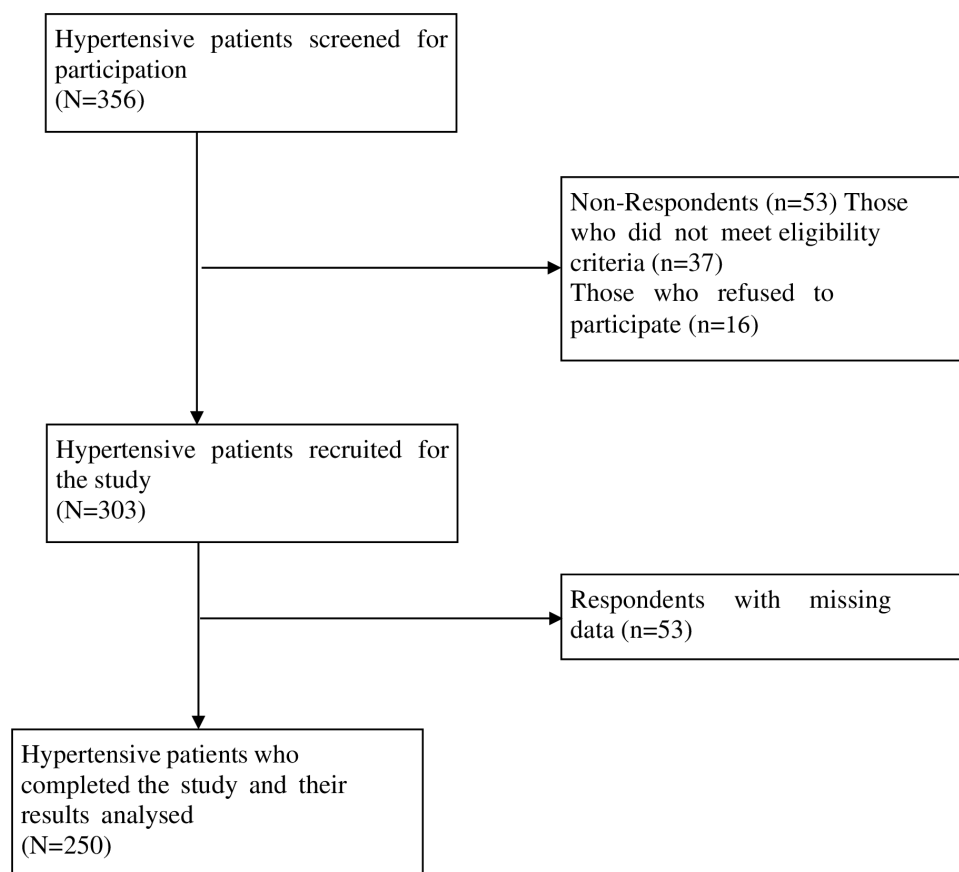
Figure 1 Flowchart of participant selection.

Table 1	Sociodemographic characteristics of respondents	
Variable	**Frequency (n=250)**	**Per cent (%)**
Age as at last birthday (years)		
<40	46	18.4
40–59	139	55.6
≥60	65	26.0
Sex		
Female	156	62.4
Male	94	37.6
Marital status		
Married	135	54.0
Unmarried*	115	46.0
Ethnic group		
Esan	125	50.0
Afenmai	113	45.2
Others	12	4.8

Mean age±SD in years=51.5 ± 10.0.
*Single, separated, divorced or widowed.

54.0%) and belonging to the Esan tribe (125, 50.0%). The sociodemographic characteristics of the participants are summarised in table 1.

Sleep patterns and blood pressure control

A substantial proportion of participants reported non-restorative sleep (160, 64.0%), which was paralleled by a high prevalence of uncontrolled blood pressure (191, 76.4%), resulting in a relatively low blood pressure control rate of 23.6%. The association between sleep pattern and blood pressure control was statistically significant (p<0.0001), with a higher proportion of respondents with restorative sleep having controlled blood pressure. The detailed results are presented in tables 2 and 3.

Association between sleep pattern and blood pressure control

After adjusting for sociodemographic variables, respondents with non-restorative sleep exhibited significantly higher odds of having uncontrolled blood pressure, with an adjusted OR of 4.38 (95%

Table 2	Sleep pattern and blood pressure control	
Variable	**Frequency (n=250)**	**Per cent (%)**
Sleep pattern		
Restorative (healthy) sleep	90	36.0
Non-restorative sleep	160	64.0
Blood pressure control*		
Controlled	59	23.6
Uncontrolled	191	76.4

*Controlled BP is systolic BP <140 mm Hg and diastolic BP <90 mm Hg while uncontrolled BP is systolic BP ≥140 mm Hg and/or diastolic BP ≥90 mm Hg.
BP, blood pressure.

CI=2.37–8.10; p<0.0001). Additionally, respondents aged 60 years and above had 3.5 times higher odds of experiencing non-restorative sleep compared with those aged 40 years and below (aOR=3.46; 95% CI=1.37–8.74; p=0.009). The results of the multivariable logistic regression are shown in tables 4 and 5.

DISCUSSION

This study was conducted to determine the association between sleep quality and BP control among patients with hypertension presenting to the Family Medicine Clinics of Irrua Specialist Teaching Hospital, Irrua, Edo State, Southern Nigeria. Notably, a substantial proportion of participants in this study reported non-restorative sleep (64.0%), which was paralleled by a high prevalence of uncontrolled blood pressure (76.4%), yielding a relatively low BP control rate of 23.6%. This alarming finding underscores the potential interplay between sleep quality and blood pressure regulation in this cohort. The finding of the high prevalence of non-restorative sleep of 64.0% among hypertensive patients in a rural setting was much higher than the reported prevalence of non-restorative sleep or poor sleep quality, 35.5% and 37.7% among similar populations in Northwest Ethiopia.[17 21] It was however similar to the finding in a cross-sectional, hospital-based study among hypertensive adults within an urban China Province where a prevalence of 60.4% was reported.[22] The similarities in the prevalence in rural and urban settings can be attributed to the referral nature of these centres. This high prevalence has important implications regarding blood pressure control and the increasing morbidity from cardiovascular disease.[23]

Restorative or healthy sleep in this study was characterised by 7–9 hours of sleep duration. Only 36.0% of participants in this study reported this duration of sleep. A similar trend of poor sleep duration was reported among US workers by the US Centres for Disease Control and Prevention with a prevalence of 24.1%–41.6%, the higher prevalence occurring in those who worked night shifts.[24]

The majority of participants in this study were middle-aged and predominantly female, with a mean age of 51.5±10.0 years. These demographic characteristics mirror the typical profile of hypertensive patients in outpatient settings, and they further underscore the relevance of the study's findings within this specific patient group.[25] The female predominance aligns with existing literature that indicates a higher prevalence of sleep disturbances among women, often attributed to hormonal fluctuations and other gender-specific factors.[26 27]

Importantly, adjusting for sociodemographic variables revealed a compelling association between non-restorative sleep and uncontrolled blood pressure in this study. Respondents with non-restorative sleep exhibited significantly higher odds of having uncontrolled blood pressure, highlighting the potential impact of sleep quality on blood pressure outcomes. These findings

Table 3 Association between sleep patterns and BP control

Sleep pattern	Controlled BP n=59 n (%)	Uncontrolled BP n=191 n (%)	χ^2	P value
Restorative sleep	37 (62.7)	53 (27.7)	23.916	<0.0001
Non-restorative sleep	22 (37.3)	138 (72.3)		

BP, blood pressure.

concur with existing literature that underscores the intricate relationship between sleep disturbances, particularly non-restorative sleep, and the exacerbation of hypertension.[8 10] The Nurses' Health Study also reported significantly higher odds of high blood pressure among women who slept for 5 hours per night or less than women who slept for 7 hours per night.[26]

Findings from the 2007–2014 NHANES in the USA reported short sleep duration, difficulty in initiating sleep and sleep disorders as being significant risks for hypertension.[10] Other studies report a significant correlation between poor sleep quality and several factors including stage II hypertension, obesity and female gender.[15 22 26–30] An observational study conducted in a tertiary hospital in India reported poor sleep quality in 77.4% of hypertensive adults with a significant association noted between sleep quality and the different stages of hypertension, particularly stage II hypertension.[30] The odds of hypertension occurring with poor sleep quality were also high among the female gender and those with stage III hypertension as reported by Guo et al.[29] Obesity among the majority of participants in the India study (66.07%) could also serve as a mediating factor in the development of hypertension.[27 28]

The multivariate analysis of sociodemographic characteristics including gender with restorative sleep revealed no significant association in this current study. This is in variance to a meta-analysis of cross-sectional studies which observed an increased risk of hypertension among women likely from the effects of poor sleep patterns.[29] To buttress this further, a review of data among 700 000 participants from a combination of the 2007–2016 National Health Interview Surveys and the 2013 Behavioural Risk Factor Surveillance System showed a higher association between poor sleep patterns and hypertension in women irrespective of their age.[30] The odds of having hypertension are also reported to be higher in individuals with obstructive

sleep apnoea, although obstructive sleep apnoea (OSA) screening was not done in the current study.[15] Obesity is however a known mediator in the development of both hypertension and OSA.[15]

In this study, age emerged as a notable predictor of sleep quality. The odds of experiencing non-restorative sleep increased with advancing age, with respondents aged 60 years and above showing a significantly higher likelihood of non-restorative sleep compared with their younger counterparts. This phenomenon has been reported in previous studies, revealing a trend where older individuals tend to experience sleep disturbances at a greater frequency, potentially due to various physiological and lifestyle factors.[31 32] Sleep disturbances include increased nocturnal awakenings and difficulty initiating sleep after nocturnal awakening.[31] However, the NHANE Survey reported positive correlations between poor sleep patterns and the risk of developing hypertension irrespective of age group.[10]

Sleep disturbance alters the circadian rhythm leading to increased sympathetic activities as well as reduced parasympathetic activity. This is in addition to stimulating the hunger centre leading to increased craving. This leads to

Table 4 Multivariable binary logistic regression showing the association between sleep pattern and BP control

Variable	Adjusted OR	95% CI	P value
Sleep pattern			
Restorative sleep	Reference		
Non-restorative sleep	4.38	2.37 to 8.10	<0.0001

BP, blood pressure.

Table 5 Multivariable binary logistic regression showing the association between sociodemographic variables and sleep pattern

Variable	Adjusted OR	95% CI	P value
Age as at last birthday (years)			
<40	Reference		
40–59	1.14	0.58 to 2.25	0.702
≥60	3.46	1.37 to 8.74	0.009
Sex			
Female	Reference		
Male	0.62	0.30 to 1.28	0.196
Marital status			
Married	Reference		
Unmarried	1.52	0.70 to 3.33	0.293
Ethnic group			
Esan	Reference		
Afenmai	2.57	1.12 to 5.92	0.027
Others	3.16	0.66 to 15.04	0.148

obesity, atherosclerosis and increased risk of DM, hypertension and metabolic syndrome.[13 15] Measures that will improve sleep quality will reduce the risk of hypertension and improve BP control.

The cross-sectional nature of this study makes it impossible to establish a causal-effect relationship between sleep quality and BP control. However, findings from the study established an association between sleep quality and BP control. This implies clinical practice in the management of hypertension.

Also, reliance on self-reported sleep quality may introduce recall bias and misclassification. However, this was minimised by comparing patients' reports to clinical evidence from patients' records on the use of sleep medications, history of sleep disturbance or current treatment of sleep disorders.

CONCLUSIONS

This study highlights the critical role of sleep quality in blood pressure control among hypertensive patients in a rural Nigerian setting. There was a high prevalence of non-restorative sleep (64.0%) and its association with uncontrolled blood pressure among patients with hypertension in Southern Nigeria.

Further studies are recommended on the effect of sleep quality on blood pressure control using a randomised controlled trial to be able to establish or dismiss the existence of a causal relationship between sleep quality and blood pressure control.

Author affiliations
[1]Family Medicine, Edo State University Uzairue, Iyamho, Nigeria
[2]Department of Family Medicine, Edo State University Teaching Hospital Auchi, Auchi, Nigeria
[3]Family Medicine, University of Calabar, Calabar, Nigeria
[4]Community Medicine, University of Calabar, Calabar, Nigeria
[5]Family Medicine, Lagos State University Teaching Hospital, Lagos, Nigeria
[6]University of Calabar Teaching Hospital, Calabar, Nigeria

ORCID iD
Tijani Idris Ahmad Oseni http://orcid.org/0000-0001-5301-1983

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