ORIGINAL RESEARCH ARTICLE

Anxiety, depression, and loneliness as key predictors of sleep disturbances in hypertensive elderly

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ABSTRACT

Background: Sleep disorders are prevalent among older adults and are frequently linked to psychological factors such as depression, anxiety, and loneliness. Understanding the prevalence and contributing factors of sleep disorders in this population is crucial for developing targeted interventions. This study aimed to identify the factors associated with sleep disorders and to examine their relationship with psychological factors in the elderly.

Methods: A cross-sectional study was conducted among older adults aged ≥60 years. Data on demographic and health-related characteristics were collected using structured interviews. Sleep disorders were assessed using the Pittsburgh Sleep Quality Index (PSQI). Depression, anxiety, and loneliness were evaluated with the Geriatric Depression Scale–30 (GDS-30), Hamilton Anxiety Scale (HAM-A), and UCLA Loneliness Scale, respectively.

Results: Among 414 elderly hypertensive patients, the mean PSQI score was 9.72, with 86.5% classified as having poor sleep quality. Older age (≥75 years) significantly increased the risk of sleep disturbance (OR = 1.9, $p = 0.037$). Depression (OR = 7–11, $p < 0.001$), anxiety (OR = 7.7, $p < 0.001$), and loneliness ($p < 0.001$) were strongly associated with poor sleep quality, while low quality of life markedly increased the risk (OR = 4.7, $p < 0.001$). ROC analysis showed that the Hamilton Anxiety Scale (AUC = 0.797) and GDS-30 (AUC = 0.748) had the best predictive value, followed by loneliness (AUC = 0.711).

Discussion: Sleep disorders are prevalent among older adults and are strongly associated with depressive symptoms, anxiety, and loneliness. Integrating mental health screening using validated instruments such as the

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GDS-30, HAM-A, and UCLA Loneliness Scale into geriatric care could improve the detection and management of sleep problems in this population.

Key words: sleep quality, hypertension, elderly, depression, anxiety, loneliness, vietnam

Introduction

The elderly population (aged 60 and above, according to the Vietnamese definition of older adults) is rapidly increasing in most countries and regions, with projections indicating a continued strong rise in the coming decades. As of 2021, the number of elderly individuals worldwide exceeded 1 billion, accounting for approximately 13.5% of the global population. This group is now a focal point in many action programs concerning aging and health (1, 2). In Vietnam, there are about 16.1 million elderly people, making up over 16% of the population. Vietnam is one of the fastest aging countries in Asia, with the transition from an aging population to an aged population occurring in just 17 to 20 years (3). Hypertension is one of the most common cardiovascular diseases, particularly among the elderly, affecting around 1 billion people globally. According to estimates from the World Health Organization, high blood pressure is responsible for approximately 9 million deaths each year, with up to 7.6 million of those being premature deaths (accounting for 13.5% of total global deaths) due to uncontrolled hypertension (4). Sleep quality is a crucial factor in cardiovascular and overall health (5). Increasing evidence shows that poor sleep is closely associated with adverse metabolic, endocrine, and cardiovascular outcomes (6). Moreover, sleep and mental health are strongly interconnected - sleep disturbances are both a cause and a consequence of mental health disorders such as depression, anxiety, and loneliness, which themselves are risk factors for cardiovascular disease through pathways involving sympathetic overactivity, elevated cortisol levels, and endothelial dysfunction (7-10). Age and health status are significant biological factors influencing sleep quality (11). As people age, physiological changes, such as a reduction in deep sleep duration and decreased melatonin secretion (9), along with an increase in chronic diseases, lead to more disrupted sleep (10). Gender is also a relevant factor, as women experience a higher rate of sleep disorders than men, especially during the perimenopausal and menopausal stages. Additionally, chronic conditions such as hypertension, diabetes, chronic obstructive pulmonary disease (11), chronic pain (12) and cardiovascular diseases (13) are closely linked to insomnia and decreased sleep quality (11). Psychological factors - such as mental health (14, 15), prolonged stress (15), and loneliness (16) - also affect sleep quality. Moreover, daily habits such as alcohol consumption (17), tobacco use (18), caffeine intake, or frequent use of stimulants (19) significantly impact sleep. Moderate physical activity can improve sleep, but excessive exercise or late-day workouts may hinder it (20). Irregular sleep patterns, prolonged late-night activities, or excessive use of electronic devices before bed negatively affect sleep quality (21). Thus, adopting a healthy lifestyle with regular sleep schedules and limited stimulant use is a practical approach to improving sleep. Living environment and social conditions profoundly influence sleep. Noise, light, high population density, or stressful urban settings can disrupt sleep (22). Additionally, socioeconomic conditions play an essential role; individuals with low income or living in challenging circumstances often face greater obstacles in maintaining quality sleep. Cultural and social factors, such as family habits, beliefs about sleep, and community influences, also shape individual sleep quality (23). This indicates that sleep is not solely dependent on biological or psychological characteristics but is also the result of a combination of social and environmental factors. For the elderly, managing blood pressure is particularly challenging due to the effects of aging, the presence of comorbid conditions, and lifestyle factors. Sleep disorders are especially noteworthy, as they not only affect quality of life but also directly impact the ability to control blood pressure. Research

has shown a correlation between poor sleep and increased sympathetic nervous system activity, disrupted circadian rhythms, and elevated cortisol levels - factors that contribute to higher blood pressure and cardiovascular complications (24, 25). Furthermore, sleep disorders are considered a risk factor for premature mortality (26), weight gain and obesity (27), diabetes, metabolic disorders (28) and mental health issues (29). However, in Vietnam, research exploring the interplay between sleep quality, psychological well-being, and hypertension remains limited. Therefore, the present study aimed to assess sleep quality and its related factors, including depression, anxiety, and lonelines, among elderly patients with hypertension, in order to provide evidence to guide future interventions for improving blood pressure management and overall well-being.

Methods

Study design and participants

This cross-sectional study was conducted on hypertensive patients aged 60 years and older who were inpatients at the Department of Geriatrics, Can Tho Central General Hospital, from March 2020 to February 2022. The age cutoff of 60 years was established in accordance with the Vietnamese Law on the Elderly of the Government of Vietnam (30) and United Nations Population Fund (31), which classify individuals aged 60 years and above elderly. Participants were included if they had a confirmed diagnosis of hypertension, were able to communicate, and consented to participate. Those with severe cognitive impairment, acute illness, or hearing difficulties that interfered with the interview were excluded.

Sample size: The sample size was calculated using the formula for estimating a proportion:

$$n = \frac{z^2_{1-\alpha/2} p(1-p)}{d^2}$$

Where: n is the required sample size; α = 0.05, statistical significance level; d = 0.05, desired accuracy; Z(1-α/2) = 1.96, Z value from the Z table corresponding to the chosen α; p = 0.5, estimated prevalence of sleep disorders among elderly hypertensive patients (since there has been no similar study in Vietnam, p was set at 0.5). We anticipated a 5% margin of error, yielding a minimum sample size of 405. In practice, we collected 450 samples, and after excluding unsuitable samples, the final number was 414.

Data collection tools and sampling method

Data collection tools

Data were collected through structured face-to-face interviews and medical record reviews. Demographic and clinical variables included age, sex, educational level, marital status, poverty status, duration and grade of hypertension, hypertension complications, medication adherence. Medication adherence is defined as the active and intentional decision by patients to follow the instructions of their healthcare providers, as measured by the General Medication Adherence Scale (GMAS). Non-adherence can be either intentional or unintentional, as exhibited by missed doses or incorrect medication use (32). The scale contains 11 questions, each scored from 0 to 3, with total scores ranging from 0 to 33: very good adherence (30–33 points), good adherence (27–29 points), partial adherence (17–26 points), low adherence (11–16 points), and poor adherence (0–10 points) (33, 34).

Following these, participants completed a series of standardized assessment tools administered in the same sequence:

- **Pittsburgh Sleep Quality Index (PSQI):** This consists of 3 sections and 9 items assessing various aspects: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. Each item is scored from 0 to 3, with total PSQI scores ranging from 0 to 21; higher scores indicate greater sleep disturbances. The interpretation is as follows: 0–4 points (normal sleep), ≥5 points (sleep disturbances) (7).
- **Substance Abuse:** Defined as the misuse of drugs or substances related to (1) using prescription or over-the-counter medications beyond the recommended dosages and (2) any non-medical

use of drugs or substances. Assessment is based on the Drug Abuse Screening Test (DAST), which focuses on the individual's relationship with substances. A score of "1" is given for each "Yes" response, except for questions 4, 5, and 7, where "No" responses do not receive a score. A score of 6 to 11 is considered optimal for screening substance use disorders; scores above 12 indicate substance abuse issues (35).

- **Depression Diagnosis (ICD-10):** Recorded in medical records. Depression is characterized by persistent feelings of sadness, loss of interest in daily activities, and cognitive, behavioral, and physical symptoms. It significantly affects quality of life and social relationships (36).
- **Geriatric Depression Scale (GDS-30):** This scale has 30 questions related to depression in the elderly, with responses of "yes" or "no." The scoring categorizes individuals into depressed (≥10 points) and non-depressed (<10 points) (37).
- **UCLA Loneliness Scale (UCLA-3):** Loneliness is defined as a subjective experience that occurs when there is a discrepancy between the social relationships an individual desires and what they actually have (38). Patients indicate how often each statement describes them, with higher scores indicating greater loneliness (39).
- **Quality of Life (QoL):** A multidimensional concept reflecting how individuals feel about their place within their culture and environment (40). Quality of life ratings were calculated by taking the total quality of life score (WHOQoL-65) (41, 42), 65 items rated on a 5-point likert scale. Total scores were categorized as: 65–194 (low), 195–259 (moderate), 260–325 (good).
- **Sampling method:** Convenient sampling, where patients meeting the criteria were selected until the required sample size was achieved.

Data collection method

- Direct interviews with patients or their relatives, combined with medical record reviews.
- Collecting demographic information, medication adherence, health conditions, and comorbidities.
- Assessing depression, sleep, quality of life, and loneliness using standardized scales.

Procedures:

- Develop a research medical record.
- Train the research team: consisting of 9 doctors from two psychiatry departments and four public health departments, along with three from the Geriatric Department.
- Data collection: invite participants, explain the study's objectives, and obtain consent. Interviews were scheduled in the afternoon (2 PM–5 PM) or evening (7 PM–9 PM) to avoid meal or treatment times.
- Support patients: provide breaks of 15–30 minutes if needed, or split the interview into smaller sessions.

Error control methods

The research team received thorough training prior to data collection to ensure consistency and reliability. The principal investigator supervised the data collection, regularly checking data quality and providing timely support for any issues. Recall bias was minimized by supplementing information from medical records and conducting detailed interviews in a comfortable atmosphere. During the COVID-19 pandemic, data collection adhered to safety regulations. Data entry was performed concurrently and regularly cross-checked to detect and correct errors, ensuring the accuracy and integrity of the information.

Data entry and analysis methods

Data were entered using Epidata 3.1 and processed in SPSS 22.0. Each medical record was entered twice for comparison to reduce errors. The sample size was predetermined based on the formula for estimating a proportion, as described in the Methods section. Descriptive Statistics: For quantitative variables, mean, standard deviation, and min-max values were presented. For qualitative variables, frequency and percentage were provided. Related Factor Analysis: Univariate analysis included Chi-square tests ($p<0.05$) and

t-tests (or log-transformation if not normally distributed). Multivariate analysis used multivariate logistic regression with the Backward Wald method. Variables with p ≤ 0.2 in univariate analysis were included in the model.

Research ethics

In this study, ethical principles were strictly followed to ensure the rights and safety of patients. Participation was entirely voluntary, and patients were clearly informed about the study's objectives, benefits, and risks, retaining the right to refuse or withdraw at any time without affecting their treatment. All collected information was for research purposes only, coded, and kept confidential to protect participants' identities. Furthermore, patients were provided with transparent information about the study's purpose and content prior to participation. Researchers respected participants' privacy and their right to decline to answer questions. In cases where severe depression or suicidal ideation was identified, researchers promptly communicated with the patient, family, and treating physician to arrange appropriate interventions.

Results

Sleep quality and associated factors in elderly hypertensive patients

The average PSQI score among elderly patients with hypertension was 9.72 (SD = 4.53; SE = 0.22), with a median of 10 and an interquartile range from 6 to 13. Given that the threshold for poor sleep quality is a PSQI score greater than 5, these results indicate that a significant majority of participants experience clinically significant sleep disturbances, with a prevalence rate of 86.5% (Table 1).

Demographic factors and prevalence of sleep disorders among elderly patients with hypertension

Among the 414 participants, a high prevalence of sleep disturbances was observed across all demographic groups (Table 2). Female participants showed a slightly higher rate of sleep disturbance compared to males (88.4% vs. 82.2%), although the difference was not statistically significant (OR = 1.7; p = 0.085). Sleep disturbance was significantly associated with age: patients aged ≥75 years had nearly twice the risk compared to those aged 60–74 years (OR = 1.9; p = 0.037). This relationship was confirmed when age was treated as a continuous variable (OR = 1.06 per year; p = 0.003). Marital status did not appear to influence sleep quality, as prevalence rates were similar between married and single participants (85.8% vs. 87.8%; OR = 1.2; p = 0.572). Regarding poverty status, sleep disturbances were more prevalent among individuals classified as poor (93.3% vs. 85.9%), though this difference did not reach significance (OR = 2.2; p = 0.254). Given the small number of impoverished participants (n = 30), the statistical power for this comparison was limited. Similarly, residential location was not a determining factor. Patients in rural areas had a slightly higher prevalence of sleep disturbances than those in urban areas (87.5% vs. 83.8%), but this difference was not statistically significant (OR = 1.4; p = 0.734).

Health status, mental health, and sleep disturbance rates

As shown in Table 3, the classification of hypertension (mild, moderate, or severe) did not significantly affect sleep disturbance prevalence (85–88%; p > 0.05). Patients with hypertension-related complications exhibited a higher rate of sleep disturbances (91.1% vs. 84.5%) and nearly twice the risk (OR = 1.9;

Table 1. PSQI score – sleep disturbance in elderly hypertensive patients

Number	Mean	SD	SE	Median	IQR	Min-max
414	9.72	4.53	0.22	10	6;13	0-21

Abbreviation: SD: Standard deviation; SE: Standard error; IQR: interquartile range.

Table 2. Demographic characteristics and sleep disturbance among elderly patients with hypertension.

Demographic characteristics	Total	Sleep disturbance (n = 358)		None (n = 56)		OR (95% CI of OR)	p
Sex							
Male	129	106	82.2%	23	17.8%	1 (ref.)	
Female	285	252	88.4%	33	11.6%	1.7 (0.9-3.0)	0.085
Age group							
60-74	212	176	83.0%	36	17.0%	1 (ref.)	
75-89	186	167	89.8%	19	10.2%	1.9 (1.1-3.3)	**0.037**
≥90	16	15	93.7%	1	6.3%		
Mean (SD)	*74.9 (8.4)*	*75.4 (8.4)*		*71.8 (7.8)*		*1.06 (1.02-1.10)*	***0.003***
Marital status							
Single	147	129	87.8%	18	12.2%	1 (ref.)	
Married	267	229	85.8%	38	14.2%	1.2 (0.7-2.2)	0.572
Poverty status							
Non-poor	384	330	85.9%	54	14.1%	1 (ref.)	
Poor	30	28	93.3%	2	6.7%	2.2 (0.5-10.0)	0.254
Residence							
Urban	111	93	83.8%	18	16.2%	1 (ref.)	
Rural	303	265	87.5%	38	12.5%	1.4 (0.73-2.8)	0.734

n: frequency; %: Percentage; CI: Confidence Interval

$p = 0.076$), suggesting a potential trend that merits further investigation.

Treatment adherence showed an inverse relationship with sleep quality. Patients with lower adherence tended to have more sleep disturbances; for every 1-point increase in adherence score, the odds of poor sleep increased by 13% (OR = 1.13; 95% CI: 1.01–1.27; $p = 0.044$). Substance use, as measured by the Drug Abuse Screening Test, was not associated with significant differences in sleep disturbance rates ($p > 0.05$). Psychological factors were strongly linked to sleep quality. Depression, according to ICD-10 diagnoses, increased the risk of sleep disturbances more than sevenfold (OR = 7.1; $p < 0.001$). Similarly, depression identified using the Geriatric Depression Scale–30 (GDS-30) was even more strongly associated (OR = 10.9; $p < 0.001$), with higher average GDS-30 scores among participants reporting poor sleep. Anxiety, measured by the Hamilton Anxiety Scale (HAM-A), was also a significant predictor. Participants with moderate to severe anxiety had almost universal sleep disturbances (OR = 7.7; $p < 0.001$). Each 1-point increase in HAM-A score raised the odds of poor sleep by 18% (OR = 1.18; $p < 0.001$). Loneliness, assessed using the UCLA Loneliness Scale, was another major factor. Participants with higher loneliness scores were significantly more likely to experience sleep disturbances ($p < 0.001$), with each 1-point increase corresponding to a 7% rise in risk (OR = 1.07; 95% CI: 1.04–1.11). Finally, quality of life measured by the WHOQoL-65 was inversely related to poor sleep. Those with low quality-of-life scores had a 100% prevalence of sleep disturbances, compared with 64.7% among participants with good quality of life (OR = 4.7; $p < 0.001$). Each 1-point increase in WHOQoL-65 score reduced the likelihood of poor sleep by 5% (OR = 0.95; $p < 0.001$).

Predictors of sleep quality disturbance among elderly hypertensive patients

Receiver Operating Characteristic (ROC) analysis was conducted to identify predictors of sleep quality disturbance in elderly patients with hypertension (Table 4 and Figure 1). The results indicate:

Table 3. Health status, mental health and sleep disturbance rates of elderly patients with hypertension.

Health status, mental health	Total	Sleep disturbance (n = 358)		None (n = 56)		OR (95% CI of OR)	p
Hypertension classification							
Grade 1 (mild)	141	120	85.1%	21	14.9%	1 (ref.)	
Grade 2 (moderate)	140	123	87.9%	17	12.1%	1.3 (0.64-2.5)	0.501
Grade 3 (severe)	133	115	86.5%	18	13.5%	1.1 (0.57-2.2)	0.748
Hypertension complications							
No	291	246	84.5%	45	15.5%	1 (ref.)	
Yes	123	112	91.1%	11	8.9%	1.9 (0.93-3.7)	0.076
Medication adherence (GMAS-30 Scale)							
High (30–33)	279	239	85.7%	40	14.3%	1 (ref.)	
Good (27–29)	53	49	92.5%	4	7.5%	2.1 (0.7-6.0)	0.190
Partial (17–26)	50	48	96.0%	2	4.0%	2.7 (0.8-9.2)	0.104
Low (11–16)	2	1	50.0%	1	50.0%		
Mean (SD)	*30.4 (3.5)*	*30.3 (3.6)*		*31.4 (3.2)*		*1.13 (1.1-1.27)*	***0.044***
Substance use (DAST Scale)							
None (0)	319	274	85.9%	45	14.1%	1 (ref.)	
Low (1–2)	67	58	86.6%	9	13.4%	1.1 (0.5-2.3)	0.885
Moderate (3–5)	20	18	90.0%	2	10.0%	2.1 (0.5-9.3)	0.313
Substantial (6–10)	8	8	100.0%	0	0.0%		
Mean (SD)	*0.55 (1.3)*	*0.58 (1.3)*		*0.34 (0.82)*		*1.22 (0.91-1.63)*	*0.191*
Depression (ICD-10)							
No	284	232	81.7%	52	18.3%	1 (ref.)	
Yes	130	126	96.9%	4	3.1%	7.1 (2.5-20.0)	< **0.001**
Depression (GDS-30 Scale)							
No	247	195	78.9%	52	21.1%	1 (ref.)	
Yes	167	163	97.6%	4	2.4%	10.9 (3.9-30.7)	< **0.001**
Mean (SD)	*9.1 (7.6)*	*9.9 (7.7)*		*3.8 (3.6)*		*1.2 (1.1-1.3)*	< ***0.001***
Anxiety (Hamilton-A Scale)							
Mild (≤17)	277	225	81.2%	52	18.8%	1 (ref.)	
Moderate (18–24)	75	71	94.7%	4	5.3%	7.7 (2.7-21.7)	< **0.001**
Severe (≥25)	62	62	100.0%	0	0.0%		
Mean (SD)	*14.1 (9.8)*	*15.3 (9.7)*		*6.2 (5.7)*		*1.18 (1.12-1.24)*	< ***0.001***
Loneliness (UCLA-LS3-J Scale, *Mean (SD)*	*35.2 (11.7)*	*36.2 (11.6)*		*28.5 (10.0)*		*1.07 (1.04-1.11)*	< ***0.001***
Quality of life (WHOQoL-65 Scale)							
Low (65–194)	27	27	100.0%	0	0.0%	1 (ref.)	
Moderate (195–259)	336	298	88.7%	38	11.3%		
Good (260–325)	51	33	64.7%	18	35.3%	4.7 (2.4-9.1)	< **0.001**
Mean (SD)	*231.9 (24.3)*	*228.6 (23.4)*		*252.8 (19.2)*		*0.95 (0.94-0.97)*	< ***0.001***

n: frequency; %: Percentage; CI: Confidence Interval

Table 4. Predictive factors of sleep quality disturbance among elderly patients with hypertension

Factor	UAC	S.E.	Optimal cut-off	Sensitivity	Specificity
Age (years)	0.6189	0.0399	72.5	0.58	0.59
Depression (ICD-10)	0.6403	0.0215	0.5	0.35	0.93
GDS-30 score	0.7481	0.0295	6.5	0.56	0.86
Hamilton Anxiety score	0.7972	0.0302	7.5	0.75	0.71
UCLA Loneliness score	0.7111	0.0385	30.5	0.66	0.64

Note: SE: Standard error

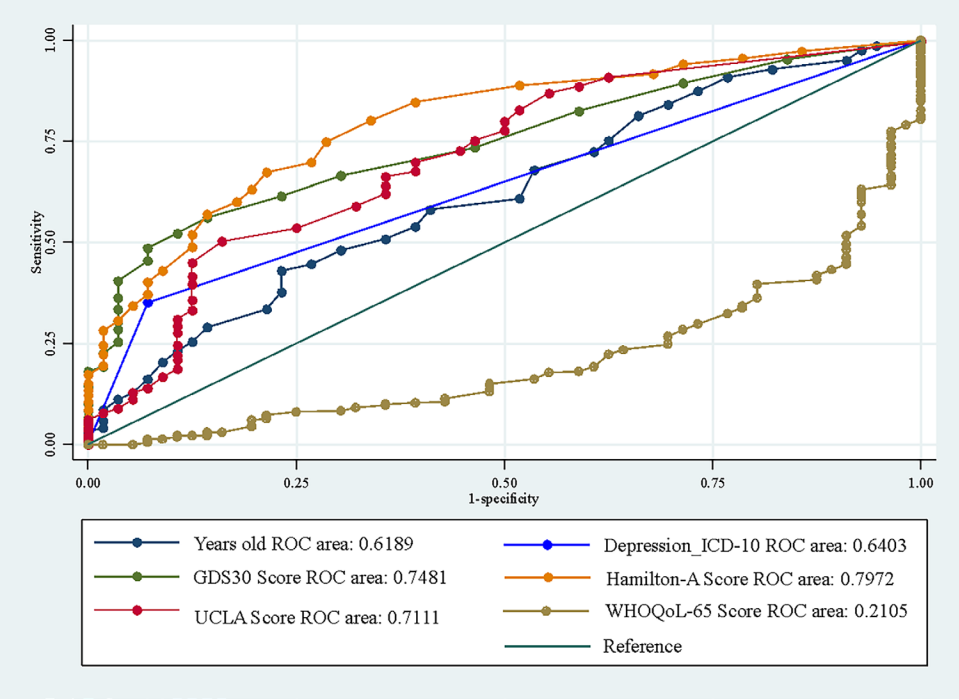

Figure 1. ROC curves of predictive factors for sleep disorders among elderly patients with hypertension.

- **Age:** Age demonstrated modest predictive value (AUC = 0.619), with a sensitivity of 58% and specificity of 59%.
- **Diagnosis of Depression (ICD-10):** Depression, based on treatment records, showed a fair discriminative ability (AUC = 0.640), with high specificity (93%) but low sensitivity (35%).
- **GDS-30 Score:** The Geriatric Depression Scale (GDS-30) significantly improved predictive capability (AUC = 0.748), with an optimal threshold of 6.5 points (sensitivity 56%, specificity 86%).
- **Hamilton Anxiety Scale:** This scale revealed the highest predictive value (AUC = 0.797), with balanced sensitivity and specificity (75% and 71%, respectively), indicating that anxiety symptoms are a strong predictor of poor sleep quality.

- **Loneliness (UCLA Scale):** Loneliness, as measured by the UCLA Loneliness Scale, also demonstrated significant predictive ability (AUC = 0.711), with sensitivity at 66% and specificity at 64%.
- **Quality of Life (WHOQoL-65):** The WHOQoL-65 exhibited a very low AUC (0.2105), indicating that quality of life does not predict sleep disturbances in this population. Conversely, higher quality of life scores were protective, correlating with a lower likelihood of sleep disturbances.

These findings underscore that psychological factors, particularly symptoms of anxiety and depression, are more accurate predictors of sleep disturbances than demographic indicators or general quality of life measures.

Disscusion

Sleep quality and associated factors in elderly hypertensive patients

The results of this study indicate that women have a higher prevalence of sleep disorders compared to men, although this difference did not reach statistical significance ($p = 0.085$). This trend aligns with many previous studies, which have often reported that women are at greater risk for sleep disorders. A systematic review by Zhang et al. (43) found that women are about 1.4 times more likely to experience insomnia than men. Similarly, a study by Yaoyao Wu et al. (44) in China noted a significantly higher rate of sleep disorders among women, particularly in patients with chronic conditions such as hypertension and diabetes. This is often attributed to hormonal factors, especially the decline in estrogen after menopause, which alters sleep architecture and increases the risk of insomnia. In Vietnam, a study by Tran et al. (45) on elderly women also reported that they experienced more sleep-related issues and less restorative sleep. However, similar to the current study, gender differences sometimes fail to reach statistical significance, potentially due to limited sample sizes or the influence of confounding factors such as depression, anxiety, and underlying health conditions. Although the results did not reach statistical significance, they reflect a general trend: elderly women have more risk factors associated with sleep disorders, including physiological changes after menopause, the burden of social and familial roles, and higher rates of mental health disorders (depression and anxiety) compared to men. Therefore, managing sleep in elderly women, especially those with hypertension, requires greater attention to psychological, social, and hormonal factors to develop appropriate intervention strategies. The average PSQI score among elderly patients with hypertension was 9.72 (SD = 4.53), with a median of 10 and an interquartile range of 6 to 13, indicating that at least half of the patients reported experiencing moderate to severe sleep disturbances. Considering the established threshold of 5 points for poor sleep quality, the majority of participants in this study clearly faced significant sleep issues (16, 46). In comparison to community-based studies of the elderly, which typically report lower average PSQI scores—such as the study by Taiji Noguchi (47), which found average PSQI scores of 4.0 (2.4), 3.9 (2.6), and 4.8 (2.9) in non-frail, pre-frail, and frail groups, respectively—this underscores that hypertension, along with advanced age, may be associated with a greater burden of sleep disturbances. Sleep issues in these patients may relate to physiological changes (such as nocturnal blood pressure fluctuations, polypharmacy, and comorbidities) as well as psychosocial factors (like stress and age-related declines in sleep efficiency). Marital status, economic status, and residence did not show statistically significant relationships with sleep disorders in elderly hypertensive patients. Overall, the demographic characteristics in this study did not indicate a strong correlation with sleep disorders in this population. Regarding hypertension classification, the high prevalence of sleep disorders (85–88%) across all three groups did not show statistically significant differences. This indicates that the degree of hypertension itself is not a direct determinant of sleep disorders; rather, sleep may be affected by complications or the burden of comorbid conditions. In fact, the group with hypertension complications

had a higher tendency for sleep disturbances compared to the non-complicated group (91.1% vs. 84.5%; OR = 1.9; p = 0.076), suggesting a potential role of comorbidities and treatment burden. Notably, adherence to treatment, as measured by the GMAS, was associated with sleep disturbances. The poorly adherent and partially adherent groups exhibited significantly higher rates of sleep disorders, and quantitative analysis indicated that lower GMAS scores were significantly associated with an increased risk of sleep disturbances (OR = 1.13; p = 0.044). This suggests that sleep disorders may impact medication adherence, and conversely, poor adherence may exacerbate health conditions and subsequently reduce sleep quality. This aligns with findings from Minjee Kim et al. (48), which indicate that persistent sleep disorders can be a significant risk factor leading to inadequate management of chronic illnesses. Mental health exhibited a strong association with sleep disorders. Both depression and anxiety showed significantly higher risks for sleep disturbances. Patients diagnosed with depression according to ICD-10 and GDS-30 had 7.1 and 10.9 times higher risks of experiencing sleep disturbances compared to non-depressed individuals ($p < 0.001$). Similarly, moderate to severe anxiety was closely related to sleep disturbances, with an OR of 7.7 for the moderate anxiety group ($p < 0.001$), and all patients with severe anxiety experienced sleep disorders. These results are consistent with previous evidence indicating a bidirectional relationship between sleep disorders and mental health: depression and anxiety are both risk factors and consequences of prolonged insomnia (7, 14, 49). Depression and anxiety have been shown to have a strong correlation with insomnia and circadian rhythm disorders (14, 15). Prolonged stress from work, studies, or life events can also increase difficulties in falling asleep, staying asleep, or waking too early (15). Furthermore, feelings of loneliness and lack of social support, particularly in the elderly, are risk factors for poor sleep (16). This highlights the importance of addressing mental health and social support environments as essential factors for improving sleep quality (49, 50). Additionally, loneliness (assessed by the UCLA Loneliness Scale) was significantly associated with sleep disturbances. The average loneliness score was significantly higher in the sleep disturbance group (36.2 vs. 28.5; $p < 0.001$), emphasizing the role of social factors and emotional support on sleep in the elderly. Loneliness in older adults is considered one of the crucial factors affecting sleep quality. Psychosocially, when lacking support from family or community, elderly individuals often experience feelings of sadness, anxiety, and insecurity, which hinder relaxation and the ability to fall asleep. Loneliness is also viewed as a form of chronic psychological stress, increasing sympathetic nervous system activity and leading to lighter, more disrupted sleep (51). Our findings are consistent with previous evidence. Hawkley and Cacioppo (2010) found that older adults living in loneliness have shorter sleep durations, poorer sleep quality, and more frequent awakenings during the night compared to those with good social connections (52). Another study in New Zealand also found loneliness to be an independent predictor of sleep disorders in older adults, even after controlling for comorbid conditions (16). These findings underscore that loneliness is not only a social issue but also a biological risk factor that directly affects the mental health and sleep of the elderly. Cortisol plays a crucial role in the pathophysiology of hypertension through mechanisms such as the regulation of vascular tone, sodium retention, and activation of the sympathetic nervous system (53). Notably, elevated cortisol levels are also associated with psychological disorders such as depression and anxiety (54). Notably, elevated cortisol levels are also associated with psychological disorders such as depression and anxiety (55) with hypertension. Another notable finding of the study is that feelings of loneliness are significantly associated with sleep disturbances, while marital status does not show a similar relationship. This paradox suggests that the subjective experience of loneliness may impact sleep quality more than objective social factors like being married or living alone. In fact, individuals can still feel lonely even when living with family or partners, indicating that the emotional aspect of social isolation is more significant than external social structures. Furthermore, the higher rates of sleep disturbances recorded in rural areas may stem from various factors. Older adults in rural areas often have limited economic resources and healthcare access, with fewer opportunities for mental health screening and support, leading to undetected and unaddressed issues such as anxiety,

depression, or loneliness. Additionally, although social relationships in rural areas tend to be stronger, urbanization and the migration of younger generations to cities have increased instances of living alone or lacking direct support, causing older adults to feel emotionally isolated. Finally, the quality of life (WHOQoL-65) showed a clear inverse relationship with sleep disorders. All patients with low quality of life experienced sleep disturbances, whereas those with high quality of life had a significantly lower prevalence of sleep disturbances (64.7%). Quantitative analysis also revealed that lower WHOQoL scores were closely associated with sleep disturbances ($p < 0.001$). One of the main reasons is that individuals with poor quality of life often face numerous physical, mental, and social challenges. Chronic illnesses, mobility limitations, or persistent pain can disrupt sleep and make it difficult to maintain (11). Simultaneously, the burden of illness, along with health and financial anxieties, can lead to stress, worry, and depression—factors known to diminish sleep quality. Previous studies have affirmed this relationship. Research by Elsa Correa-Muñoz et al. (2023) in Mexico (46) found that older adults with low WHOQoL-BREF scores are at higher risk of sleep disorders. Similarly, a study in Japan by Eise Yokoyama et al. (2010) (56) also indicated that low satisfaction with health and social life is significantly related to insomnia and poor sleep quality. This suggests that improving overall quality of life, including healthcare, psychological support, and enhancing social relationships, may be an important solution for enhancing sleep quality in the elderly. In summary, sleep disorders in elderly hypertensive patients are closely related to mental health conditions (depression, anxiety, loneliness) and quality of life rather than the severity of hypertension. This emphasizes the importance of a comprehensive assessment of physical, mental, and social health, not just focusing on hypertension treatment, to enhance sleep quality and overall health in the elderly.

Predictors of sleep quality disturbance among elderly hypertensive patients

ROC analysis aimed at identifying predictors of sleep disturbances in elderly hypertensive patients shows that mental health plays a more prominent role than demographic characteristics or quality of life. Age demonstrated limited predictive value (AUC = 0.619), with both sensitivity and specificity at moderate levels, indicating that while advanced age is a known risk factor for sleep disorders, age alone is not a strong enough predictor of this condition. Depression, recorded in treatment records according to ICD-10, exhibited fair discriminative ability (AUC = 0.640), with high specificity (93%) but low sensitivity (35%). This means that when a diagnosis of depression is present, the likelihood of predicting sleep disturbances is reliable, but many cases of sleep disturbances not clinically recorded as depression are likely missed. Notably, when using the GDS-30 scoring, predictive capability improved significantly (AUC = 0.748), with an optimal threshold of 6.5 points, indicating that this screening tool is more sensitive in detecting depression symptoms related to sleep disturbances in older adults. Anxiety, assessed using the Hamilton Anxiety Scale, emerged as the strongest predictor (AUC = 0.797), with balanced sensitivity and specificity (75% and 71%). This result underscores the important role of anxiety in the pathophysiology of sleep disorders, consistent with previous evidence that anxiety can affect both the onset and maintenance of sleep. Loneliness, measured by the UCLA Loneliness Scale, also demonstrated significant predictive value (AUC = 0.711), reflecting the psychosocial impact on sleep quality. Social isolation and feelings of disconnection can increase the risk of insomnia, particularly in vulnerable older adults. This aligns with the research of Hawkley & Cacioppo (2010), which found that older adults experiencing loneliness often have poorer sleep quality, more nighttime awakenings, and lighter sleep. In Vietnam, several community studies among older adults have also shown that a lack of social support increases the risk of insomnia and accompanying mental disorders. In contrast, quality of life (WHOQoL-65) was not a direct predictor of sleep disturbances (AUC = 0.2105). However, the inverse relationship suggests that higher quality of life scores serve a protective role, reducing the risk of sleep disturbances. This implies that rather than being a predictive factor, quality of life may be an indirect outcome of good sleep and stable mental health. In conclusion, the results show that

mental health factors (particularly anxiety and depression) along with feelings of loneliness are significant predictors of sleep disturbances in elderly hypertensive patients, while age and quality of life play limited roles. Screening and early intervention for mental health may be key to improving sleep in this population.

Limitations of the study

This study has several limitations. First, due to the use of multiple assessment tools, the research team required additional time to ensure consistent data collection, while participants—elderly individuals with multiple comorbidities—often experienced fatigue during lengthy interviews. Second, the cross-sectional design precludes causal inference between associated factors and sleep disturbances. The lack of formal psychiatric screening, absence of data on benzodiazepine or hypnotic use, and limited assessment of insomnia severity and duration also restrict the interpretation of findings. Furthermore, data collection was disrupted by the fourth wave of the COVID-19 pandemic, which altered hospital admission policies and patient characteristics at Can Tho Central General Hospital. Finally, the study defined older adults as those aged ≥60 years, following the Vietnamese Law on the Elderly (No. 39/2009/QH12). This differs from international standards (≥65 years) and may affect the comparability of results across populations.

Conclusion

The present study highlights the significant prevalence of sleep disturbances among elderly patients with hypertension, with an alarming rate of 86.5% affected. Key demographic factors, such as age, emerged as important predictors, with those aged 75 and older facing nearly double the risk of sleep disorders. While gender and economic status showed trends, they did not reach statistical significance, indicating that these factors may not play a crucial role in sleep quality among this population. Mental health factors, particularly depression and anxiety, were found to be strong predictors of sleep disturbances, with patients exhibiting anxiety symptoms having the highest predictive value. The findings suggest that interventions aimed at improving mental health could be vital in mitigating sleep issues in elderly hypertensive patients. Loneliness and low quality of life were also significantly associated with poor sleep quality, reinforcing the importance of addressing psychological well-being and social support in this demographic. Overall, the results underscore the need for comprehensive approaches that focus not only on the medical management of hypertension but also on the psychological and social factors influencing sleep quality. Future research should explore targeted interventions that address these mental health concerns to enhance sleep outcomes in elderly patients with hypertension.

Ethic Approval: Participants were informed about the study objectives, gave informed consent, and had the freedom to withdraw. Anonymity, privacy, and participant well-being were carefully ensured during data collection and reporting. The study was approved by the Ethics Council in Biomedical Research at Hanoi Medical University under decision number 72/GCN-HĐĐĐNCYSH-ĐHYHN, dated April 10, 2020.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Author's Contribution: All authors significantly contributed to this research. V.T. Nguyen and T. Nguyen designed the study; L.C. Ly and V.T. Nguyen investigated the data and applied strict exclusions. T.T.H. Nguyen analyzed the data and wrote the paper. T.V. Nguyen evaluated and revised the manuscript. V.T. Nguyen and T.D. Nguyen shaped the final version, with all authors approving it.

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Consent for publication: Written informed consent for the publication of study results was obtained from all participants.

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