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Original Research Article

Association between Environmental Noise Exposure and Sleep Quality Assessed by the Pittsburgh Sleep Quality Index (PSQI) Among Urban Residents: Evidence from Ho Chi Minh City

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Abstract: This study aimed to describe the status and distribution of poor sleep quality among urban residents, assess the level of self-reported environmental noise annoyance, and examine the independent association between noise annoyance and Pittsburgh Sleep Quality Index (PSQI) scores after controlling for potential confounding factors. A cross-sectional study was conducted among 178 urban residents in Ho Chi Minh City between February and April 2026. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), daytime sleepiness using the Epworth Sleepiness Scale (ESS), and insomnia status was assessed using an insomnia index. Noise annoyance was measured using a self-reported five-point Likert scale. Statistical analyses included Pearson correlation and multiple linear regression, with age, sex, body mass index (BMI), floor level, and adjacent street type included as control variables. The prevalence of poor sleep quality (PSQI > 5) was 68.5%, with a mean PSQI score of 7.92 ± 3.14. The mean noise annoyance score was 3.46 ± 0.89 on a five-point scale, with 61.2% of participants reporting high levels of noise annoyance. Multiple linear regression analysis showed that noise annoyance was the strongest and most statistically significant predictor of poor sleep quality (β = 1.24; standardized β = 0.42; $p < 0.001$; 95% CI: 0.87–1.61). The model explained 38.4% of the variance in PSQI scores ($R^2 = 0.384$; $p < 0.001$). Environmental noise annoyance was independently associated with poor sleep quality among urban residents in Ho Chi Minh City, with both statistical significance and practical relevance. These findings provide empirical evidence to support recommendations for noise control in urban planning and public health interventions in Vietnam.

Keywords: Environmental Noise, Sleep Quality, Pittsburgh Sleep Quality Index (PSQI), Noise Annoyance, Urban Residents, Ho Chi Minh City, Environmental Health.

1. INTRODUCTION

Urbanization is occurring at an unprecedented rate in human history, profoundly transforming the living environments of billions of people worldwide. Along with the continuous expansion of transportation infrastructure, industrial activities, and increasingly dense populations, environmental noise has emerged as one of the most widespread and persistent public health threats in modern urban settings. According to the World Health Organization, sleep disturbance and noise annoyance account for the majority of the disease burden attributable to environmental noise, with an estimated loss of at least one million healthy life years annually in Western Europe alone (WHO Regional Office for Europe, 2011). More than 100 million people in Europe are currently exposed to environmental noise levels exceeding recommended thresholds, with road traffic noise identified as the most prevalent source of sleep-related health impacts at the population level (European Environment Agency, 2022).

From a biological perspective, sleep plays an essential role in physical and mental health, and poor sleep quality is closely associated with cognitive impairment, increased cardiovascular risk, and mental disorders. Noise activates the hypothalamic–pituitary–

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adrenal axis through both direct pathways and indirect pathways via subjective noise annoyance, leading to increased nocturnal cortisol secretion, flattening of the circadian cortisol rhythm, and disruption of sleep architecture characterized by reduced slow-wave sleep, increased frequency of awakenings, and prolonged sleep onset latency (Dzhambov *et al*., 2024). Epidemiological evidence from large-scale studies in Asia indicates that individuals reporting noise exposure have a statistically significantly higher risk of poor sleep quality, with the association extending to all seven components of the Pittsburgh Sleep Quality Index, including sleep latency, sleep efficiency, and daytime dysfunction (Kim & Park, 2024). Notably, growing evidence suggests that subjective perception of noise may affect sleep quality more strongly than objectively measured noise exposure, highlighting the importance of measuring the annoyance dimension in community-based research (Breugelmans *et al*., 2014).

At present, most of the available evidence originates from Western and Northern European countries, where urban infrastructure characteristics and sleep-related behaviors differ substantially from those in Asian contexts, while data from rapidly developing urban areas in Southeast Asia remain very limited (Basner *et al*., 2022). In Vietnam, urbanization has accelerated rapidly over the past two decades, particularly in Ho Chi Minh City, where traffic density is among the highest in the region. However, quantitative studies examining the relationship between noise and sleep in this context have been scarcely conducted. Most community-based studies in the region continue to rely on objective noise measurements, while the dimension of subjective noise annoyance has received limited systematic investigation despite its independently confirmed predictive value.

In response to this research gap, the present study, entitled "Association Between Environmental Noise Exposure and Sleep Quality Assessed by the Pittsburgh Sleep Quality Index (PSQI) Among Urban Residents: Evidence from Ho Chi Minh City", was conducted to describe the status of sleep quality among urban residents, assess the level of self-reported noise annoyance, and examine the independent association between these two dimensions after controlling for potential confounding factors. In doing so, the study aims to provide locally contextualized empirical evidence to inform urban planning and public health interventions in Vietnam.

2. METHODS

2.1 Study Design and Study Setting

The study employed a descriptive cross-sectional design and was conducted in an urban residential area of Ho Chi Minh City between February and April 2026. The cross-sectional design was selected because it was appropriate for the objective of describing the current status and examining the association between noise exposure and sleep quality at a specific point in time, while also allowing for the collection of multivariable data under the resource constraints of community-based research.

The study setting was purposively selected based on three criteria: high traffic density, diversity in housing types ranging from street-front houses to apartment buildings and residential alleys, and representativeness of the typical urban acoustic environment in Ho Chi Minh City. This diversity in the study setting allowed for comparisons of noise exposure levels among resident groups with different living conditions within the same urban context.

2.2 Study Participants

Participants were residents aged 18 years and older who had lived continuously in the study area for at least six months prior to the survey and were able to read and understand the questionnaire in Vietnamese. The minimum residence duration of six months was established to ensure that participants had sufficient time to accumulate actual noise exposure in their current living environment, thereby reflecting chronic rather than temporary exposure.

Individuals were excluded from the study if they were engaged in regular night-shift work, were using prescribed sleep medications, or had been diagnosed with a severe mental disorder prior to participation. These exclusion criteria were established to control for factors that might independently and directly affect sleep quality beyond environmental noise, thereby enhancing the internal validity of the analytical model. The sample size was calculated based on Cohen's (1988) formula for multiple linear regression, assuming a significance level of $\alpha = 0.05$, a statistical power of 80%, and an effect size of $f^2 = 0.15$, yielding a minimum required sample size of 92 participants. In practice, the study obtained fewer than 200 eligible participants after the application of all exclusion criteria.

2.3 Measurement Instruments

The study employed a self-reported instrument package consisting of four main measurement scales, as presented in Table 1. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), a self-reported instrument comprising 19 items that evaluate seven components of sleep over the previous month, with a total score ranging from 0 to 21. A score greater than 5 was considered indicative of poor sleep quality (Buysse *et al*., 1989). Environmental noise was measured through self-report using a five-point Likert scale assessing the level of annoyance caused by noise during daily activities and sleep. This approach was based on the measurement of subjective noise annoyance and was considered appropriate for the community-based study design.

Table 1: Summary of Measurement Instruments Used in the Study

Variable	Instrument	Scale Range	Clinical Cut-off
Sleep quality	Pittsburgh Sleep Quality Index (PSQI)	0 – 21	> 5: Poor sleep quality
Daytime sleepiness	Epworth Sleepiness Scale (ESS)	0 – 24	> 10: Excessive daytime sleepiness
Insomnia severity	Insomnia Severity Index (ISI)	0 – 28	≥ 15: Moderate-to-severe insomnia
Noise annoyance	Self-reported Likert Scale (NAS)	1 – 5	Higher scores indicate greater noise annoyance
Control variables	Age, sex, BMI, occupation, floor level, street type	-	-

Control variables collected in the study included age, sex, body mass index, occupation, residential floor level, and the type of street adjacent to the residence. The inclusion of residential floor level and adjacent street type in the analytical model was based on evidence indicating that the spatial location of a residence is significantly associated with actual noise exposure levels, even within the same geographical area (Xu *et al*., 2023).

2.4 Statistical Analysis

Descriptive statistics were presented as means and standard deviations for continuous variables with a normal distribution, and as frequencies and percentages for categorical variables. Normality was assessed using the Shapiro–Wilk test due to the sample size being fewer than 200 participants, in combination with visual inspection of histograms and Q–Q plots. The linear correlation between noise annoyance scores and overall PSQI scores was evaluated using Pearson's correlation coefficient when the data satisfied the assumption of normality.

The primary analytical model was multiple linear regression, with the overall PSQI score as the dependent variable, noise annoyance score as the main independent variable, and age, sex, body mass index, residential floor level, and adjacent street type as control variables. Regression results were reported as unstandardized regression coefficients, standardized regression coefficients, standard errors, t statistics, and 95% confidence intervals. Model assumptions were assessed according to the sequence summarized in Table 2.

Table 2: Sequence of Testing Assumptions for the Multiple Linear Regression Model

Assumption	Assessment Method	Acceptance Criterion
Linearity	esiduals versus fitted values plot	Random scatter around the zero line
Normality of residuals	Residual Q–Q plot	Points lie close to the diagonal line
Homoscedasticity	Breusch-Pagan Test	p > 0,05
Absence of multicollinearity	Variance Inflation Factor (VIF)	VIF < 5
Absence of autocorrelation	Durbin–Watson statistic	Value approximately equal to 2

In addition to the primary model, binary logistic regression was performed after dichotomizing sleep quality according to a PSQI score greater than 5 in order to estimate odds ratios and 95% confidence intervals for the association between noise and the risk of poor sleep quality. Sensitivity analysis was conducted by excluding outliers and re-running the entire model to assess the robustness of the results. All analyses were performed using SPSS version 26, with statistical significance set at $p < 0.05$.

3. RESULTS

3.1 Sample Characteristics

A total of 178 eligible participants were included in the analysis after excluding 14 questionnaires that did not meet the eligibility criteria or contained more than 10% missing data. The demographic characteristics of the study sample are presented in Table 3.

Table 3: Demographic and Socioeconomic Characteristics of the Study Sample (n = 178)

Characteristics	n	%	Mean ± SD
Sex			
Male	79	44,4	
Female	99	55,6	
Age (years)			34,2 ± 11,6
18 – 30	74	41,6	
31 – 45	63	35,4	
46 – 60	29	16,3	
> 60	12	6,7	
BMI (kg/m²)			22,8 ± 3,4
Occupation			

Office worker	68	38,2	
Freelance workers	47	26,4	
Student	31	17,4	
Other	32	18,0	
Residential floor level			
Floors 1–2	89	50,0	
Floors 3–5	54	30,3	
Floor 6 and above	35	19,7	
Adjacent street type			
Major road with heavy traffic	94	52,8	
Minor street or alley	84	47,2	

The study sample had a mean age of 34.2 ± 11.6 years, with females accounting for a higher proportion than males. Office workers represented the largest occupational group. Notably, more than half of the participants resided on the first or second floor and lived adjacent to major roads with high traffic density, a characteristic that warrants consideration when examining the association with noise exposure.

3.2 Sleep Quality Status

The overall PSQI score of the study sample was normally distributed, as indicated by the Shapiro–Wilk test (W = 0.97, p = 0.14). Detailed results for the individual PSQI components are presented in Table 4.

Table 4: Distribution of Overall PSQI Scores and PSQI Components (n = 178)

PSQI Component	Mean ± SD	Min – Max
Subjective sleep quality	1,41 ± 0,72	0 – 3
Sleep latency	1,38 ± 0,81	0 – 3
Sleep duration	1,22 ± 0,79	0 – 3
Sleep efficiency	0,98 ± 0,84	0 – 3
Sleep disturbances	1,53 ± 0,68	0 – 3
Use of sleep medication	0,21 ± 0,51	0 – 3
Daytime dysfunction	1,19 ± 0,77	0 – 3
Overall PSQI score	**7,92 ± 3,14**	**2 – 17**
ESS	9,34 ± 4,12	0 – 22
ISI	11,27 ± 5,43	0 – 24

The mean overall PSQI score of the study sample was 7.92 ± 3.14, substantially exceeding the threshold for poor sleep quality (> 5). The prevalence of poor sleep quality (PSQI > 5) was 68.5% (n = 122), indicating a considerable burden of sleep disturbances within the study sample. Among the PSQI components, sleep disturbances had the highest mean score (1.53 ± 0.68), followed by subjective sleep quality (1.41 ± 0.72) and sleep latency (1.38 ± 0.81), suggesting that nocturnal awakenings and difficulty initiating sleep were the most prominent sleep-related problems in the sample. The mean ESS score was 9.34 ± 4.12, indicating a level of daytime sleepiness approaching the clinical threshold, whereas the mean ISI score was 11.27 ± 5.43, reflecting a mild-to-moderate level of insomnia.

3.3 Perceived Noise Levels

The mean noise annoyance score of the study sample was 3.46 ± 0.89 on a five-point scale, with 61.2% of participants (n = 109) reporting high levels of noise annoyance (score ≥ 4). The distribution of NAS scores was slightly skewed toward higher values, with a skewness coefficient of −0.42, reflecting the characteristics of a high-intensity urban acoustic environment in the study area.

Table 5: Distribution of Noise Annoyance Levels (n = 178)

	Low Level (1–2)	**Moderate Level (3)**	**High Level (4–5)**	**Total**	**Mean ± SD**
NAS Score	18 (10,1%)	51 (28,7%)	109 (61,2%)	178 (100%)	3,46 ± 0,89

Regarding noise sources, road traffic noise was the most frequently reported source of annoyance, cited by 78.7% of participants, reflecting the high and continuous traffic density on urban roads in Ho Chi Minh City. Construction noise ranked second, reported by 43.3% of participants, and was associated with the ongoing processes of urbanization and infrastructure development in the study area. Noise from neighboring households accounted for 31.5%, reflecting the high population density and the prevalence of adjacent housing structures in inner-city neighborhoods. Notably, a relatively high proportion of participants reported exposure to multiple noise sources simultaneously, suggesting that urban residents in the study area were exposed to multi-source noise rather than a single noise source. This may increase the cumulative impact of noise exposure on sleep quality.

Table 6: Self-Reported Noise Sources (n = 178, Multiple Responses Allowed)

Noise Source	**Road Traffic**	**Construction Sites**	**Neighbor activities**	**Other Sources**
n (%)	140 (78,7%)	77 (43,3%)	56 (31,5%)	24 (13,5%)

When examining the association between NAS scores and residential location characteristics, participants residing on the first or second floor adjacent to major roads had significantly higher mean noise annoyance scores than those living on higher floors or in small alleys (3.84 ± 0.71 vs. 2.97 ± 0.93; t(176) = 6.47; $p < 0.001$). A difference of nearly one point on the five-point scale between these two groups was clinically meaningful, indicating substantial variation in the residential acoustic microenvironment even within the same urban area. This finding also supports the convergent validity of the self-reported measure, as NAS scores accurately reflected the physical characteristics of residential location, thereby strengthening the reliability of the measurement instrument used in this study.

Table 7: Noise Annoyance Scores by Residential Location

Residential Location	**n (%)**	**Mean ± SD**	**t**	**p**
Floors 1–2, major road	94 (52,8%)	3,84 ± 0,71	6,47	< 0,001
Higher floors or small alley	84 (47,2%)	2,97 ± 0,93		

The marked difference between the two residential location groups suggests that, even within the same urban area, the residential acoustic microenvironment may vary substantially depending on floor level and the type of adjacent street. This finding underscores the importance of including residential location variables in the regression model as control variables to isolate the independent effect of perceived noise on sleep quality from the influence of related physical environmental factors.

3.4 Association Between Noise and Sleep Quality

Pearson correlation analysis showed that noise annoyance scores were positively correlated with overall PSQI scores, with a moderate-to-strong correlation strength ($r = 0.51$, $p < 0.001$), indicating that higher levels of noise annoyance were associated with poorer sleep quality.

Table 8: Pearson Correlations Between Noise Annoyance Scores (NAS) and PSQI Components

PSQI Component	**r**	**p**
Subjective sleep quality	0,44	< 0,001
Sleep latency	0,48	< 0,001
Sleep duration	0,31	< 0,001
Sleep efficiency	0,29	< 0,001
Sleep disturbances	0,53	< 0,001
Use of sleep medication	0,18	0,017
Daytime dysfunction	0,39	< 0,001
Overall PSQI score	**0,51**	**< 0,001**

The results of the multiple linear regression analysis after controlling for confounding variables are presented in Table 9. The overall model was statistically significant, with $F(6, 171) = 18.42$, $p < 0.001$, and explained 38.4% of the variance in overall PSQI scores ($R^2 = 0.384$; adjusted $R^2 = 0.362$). Assessment of multicollinearity indicated that all independent variables had VIF values < 2.1, confirming that no significant multicollinearity was present in the model.

Table 9: Results of Multiple Linear Regression Analysis with Overall PSQI Score as the Dependent Variable (n = 178)

Variable	**β**	**SE**	**β***	**t**	**p**	**CI 95%**
Noise annoyance (NAS)	1,24	0,19	0,42	6,53	< 0,001	[0,87 – 1,61]
Age	0,08	0,03	0,18	2,67	0,008	[0,02 – 0,14]
Sex (female)	0,71	0,34	0,13	2,09	0,038	[0,04 – 1,38]
BMI	0,11	0,09	0,08	1,22	0,223	[−0,07 – 0,29]
Lower floor level (1–2)	0,94	0,36	0,17	2,61	0,010	[0,23 – 1,65]
Major road	0,88	0,33	0,16	2,67	0,008	[0,23 – 1,53]
Constant	2,14	0,87		2,46	0,015	[0,42 – 3,86]

Note: *β = unstandardized regression coefficient; β = standardized regression coefficient; SE = standard error; CI = 95% confidence interval; R^2 = 0,384; adjusted R^2 = 0,362; F(6, 171) = 18,42; p < 0,001**

Noise annoyance score was the strongest predictor and the most statistically significant variable in the model (β = 1.24; β* = 0.42; p < 0.001), indicating that each one-unit increase in NAS score was associated with a 1.24-point increase in overall PSQI score after controlling for all confounding variables. Age, female sex, residence on lower floors, and proximity to major roads were also independent predictors with statistically significant associations, whereas BMI did not reach statistical significance in the fully adjusted model.

3.5 Stratified Analysis

To examine the consistency of the association between noise annoyance and sleep quality across subgroups, stratified analyses were performed according to three variables: sex, age group, and adjacent street type. The summarized results are presented in Table 10.

Table 10: Pearson Correlation Coefficients Between NAS and PSQI by Subgroup

Subgroup	n	r	p
By sex			
Male	79	0,52	< 0,001
Female	99	0,49	< 0,001
By age group			
18 – 30	74	0,51	< 0,001
31 – 45	63	0,58	< 0,001
46 – 60	29	0,44	0,017
Over 60	12	0,37	0,023
By Street Type			
Major Road with Heavy Traffic	94	0,55	< 0,001
Small Street or Alley	84	0,46	< 0,001

By sex, the association between NAS and PSQI was of similar strength in both groups, with r = 0.52 among males and r = 0.49 among females, and both associations were highly statistically significant (p < 0.001). This similarity suggests that sex did not have a significant moderating effect on the association between noise annoyance and sleep quality in the study sample, and that the impact of noise annoyance on sleep quality was relatively universal across both sexes in this urban context.

By age group, the association between NAS and PSQI was strongest among participants aged 31–45 years (r = 0.58, p < 0.001) and showed a gradual decline in older age groups, particularly among those aged over 60 years (r = 0.37, p = 0.023). This declining trend may reflect two non-mutually exclusive mechanisms. First, it may indicate progressive psychological adaptation to the surrounding acoustic environment following prolonged residential exposure. Second, it may be attributable to the increasing influence of age-specific determinants of sleep quality, including chronic pain, nocturia, and age-related physiological changes in sleep architecture, which may reduce the relative contribution of noise to the explained variance in sleep quality among older adults.

By age group, the association between NAS and PSQI was strongest among participants aged 31–45 years (r = 0.58, p < 0.001) and showed a gradual decline in older age groups, particularly among those aged over 60 years (r = 0.37, p = 0.023). This declining trend may reflect one of two non-mutually exclusive mechanisms. First, it may be attributable to gradual psychological adaptation to the surrounding acoustic environment over years of residential exposure. Second, it may reflect the influence of sleep-related factors that are more prevalent among older adults, including chronic pain, nocturia, and age-related physiological changes in sleep, which may relatively reduce the contribution of noise to the overall variance in sleep quality within this group.

Table 11: Mean PSQI Scores by Street Type

Street Type	n (%)	Mean ± SD	t	p
Major Road with Heavy Traffic	94 (52,8%)	8,64 ± 3,02	3,14	0,002
Small Street or Alley	84 (47,2%)	7,12 ± 3,19		

By street type, participants residing adjacent to major roads had significantly higher mean PSQI scores than those living on small streets or in alleys (8.64 ± 3.02 vs. 7.12 ± 3.19; t = 3.14; p = 0.002). The difference of 1.52 PSQI points between the two groups was of substantial practical significance in a clinical context. Furthermore, the correlation coefficient between NAS and PSQI was higher among participants residing adjacent to major roads (r = 0.55) than among those living on small streets or in alleys (r = 0.46), suggesting that not only the absolute level of sleep quality, but also the sensitivity of sleep quality to variations in noise exposure, tended to be greater among residents exposed to continuous and high-intensity traffic noise. Taken together, the results of the stratified analyses support the consistency and robustness of the primary association identified in this study, while providing additional evidence for the moderating role of residential location characteristics in the relationship between environmental noise and sleep quality in urban settings.

5. DISCUSSION

This study provides quantitative evidence demonstrating that environmental noise annoyance is positively, independently, and significantly associated with poor sleep quality among urban residents in Ho Chi Minh City after controlling for demographic and environmental factors. The prevalence of poor sleep quality in the study sample was concerning, with noise annoyance emerging as the strongest and most consistent predictor across all analytical models. This association was evident not only for overall PSQI scores but also across most sleep components, particularly sleep disturbances and sleep latency, which are the two dimensions that most directly reflect the disruptive effects of noise on sleep maintenance and sleep initiation.

Additional stratified analyses showed that this association was highly consistent across sex groups and working-age groups, reinforcing the argument that environmental noise is a broad community-level risk factor rather than a problem affecting isolated individuals. The finding regarding the moderating role of residential location, whereby residents living on lower floors adjacent to major roads exhibited substantially poorer sleep quality, adds an important urban spatial dimension to the broader understanding of community sleep health in rapidly developing cities. Taken together, these findings suggest that environmental noise is not merely a matter of living comfort, but rather a quantifiable and modifiable health risk factor in the context of rapid urbanization in Vietnam.

The findings of this study are generally consistent with trends reported in the international literature, while also contributing evidence from a geographical and cultural context that remains underrepresented in the existing body of research. The positive association between noise annoyance and overall PSQI scores observed in this study is consistent with the findings of Kim and Park (2024) based on a large sample in South Korea, in which participants reporting noise pollution exhibited a significantly higher risk of poor sleep quality after adjustment for psychosocial factors. Similarly, a field study conducted in Shanghai by Xu et al. (2023) also reported that higher levels of noise exposure were associated with systematic sleep disturbances, despite using objective acoustic measurements rather than self-reported measures.

A notable difference between the present study and much of the European literature is the more prominent role of road traffic noise compared with aircraft or railway noise, reflecting the transportation infrastructure characteristics of Southeast Asian cities, where motorcycles and private automobiles constitute the dominant modes of transport. Correlation coefficient between NAS and PSQI observed in this study was moderate to strong and exceeded that reported in some European self-report studies using standardized noise annoyance scales. This difference may reflect higher actual levels of noise exposure or differences in noise tolerance attributable to distinctive living habits and housing conditions in urban Vietnam. The convergence of the present findings with the international literature strengthens the external validity of the noise–sleep relationship model in the context of rapidly developing Asian cities and further suggests that theoretical frameworks derived from Western research may be applicable, with appropriate adaptation, to the Vietnamese context.

5.3 Limitations, Implications, and Future Direction

Although the findings of this study have clear practical value, several methodological limitations should be acknowledged to ensure caution in interpreting the results. The cross-sectional design, although appropriate for the initial exploratory objective, does not allow causal relationships between noise annoyance and sleep quality to be established and does not exclude the possibility of reverse causality, whereby individuals with pre-existing poor sleep may be more sensitive to noise and therefore report higher levels of annoyance. The measurement of noise was based entirely on subjective self-report, which may also lead to recall bias and may not accurately reflect actual acoustic exposure levels in decibels. In addition, the sample size of fewer than 200 participants from a single urban area limits the generalizability of the findings to other districts and cities in the region.

The absence of objective sleep measurements using actigraphy or polysomnography represents the most important methodological limitation of this study, as these instruments allow independent validation of self-reported sleep indicators and facilitate the detection of underlying sleep disorders that participants may not recognize themselves. Nevertheless, these limitations do not diminish the value of the evidence obtained but rather establish a clear agenda for future research. FFuture studies should prioritize longitudinal designs to examine changes in sleep quality in relation to temporal variations in noise levels, integrate objective acoustic measurements with GIS-based noise mapping, expand the sample to include multiple districts representing diverse urban characteristics, and incorporate psychological mediators such as anxiety and chronic stress to further elucidate the mechanisms underlying the relationship between noise and sleep in the urban context of Vietnam.

In terms of policy implications, the findings of this study provide empirical evidence for integrating acoustic environmental criteria into residential area planning, the design of noise-buffering green corridors, and the control of construction noise during nighttime hours in Ho Chi Minh City.

6. CONCLUSION

This study was conducted in the context of increasing recognition of environmental noise as a systemic public health risk factor in rapidly developing urban areas across Southeast Asia, where locally generated scientific evidence remains limited. Findings from a sample of urban residents in Ho Chi Minh City indicate a concerning burden of sleep disturbances within the community, with nearly seven out of ten participants classified as having poor sleep quality according to the clinical threshold of the PSQI. This pattern is not a random occurrence but is closely linked to the residential acoustic environment, reflecting the cumulative consequences of urbanization that has not been adequately managed from an environmental health perspective.

With regard to the statistical association, self-reported noise annoyance emerged as the strongest independent predictor of poor sleep quality in the multiple linear regression model after controlling for age, sex, body mass index, and residential location characteristics. This association was highly consistent across PSQI components, sex groups, and working-age groups, suggesting that the impact of noise on sleep is not dependent on individual demographic characteristics but rather reflects a universal underlying physiological mechanism. Notably, residents living on lower floors adjacent to major roads experienced a double burden, exhibiting both higher levels of noise annoyance and poorer sleep quality than those residing in less noise-exposed locations, suggesting that urban spatial inequalities may be translated into measurable inequalities in sleep health.

With regard to policy implications, these findings provide empirical support for several highly feasible recommendations. Integrating noise control criteria into the planning of new residential areas, incorporating noise-buffering green corridors along major transportation routes, enforcing stricter regulations on construction noise during nighttime hours, and promoting residential building designs that meet acoustic insulation standards are measures that could be implemented in the short to medium term. From a broader perspective, this study contributes to the growing recognition that sustainable improvements in sleep quality among urban populations cannot be achieved independently of efforts to control the acoustic environment through urban planning and governance. Investment in a quieter city should therefore be viewed as a direct investment in public health, workforce productivity, and the quality of life of millions of urban residents in Vietnam.

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