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Noise Pollution and Its Impact on Health in Kathmandu Valley, Nepal: A Case Study

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Abstract

Noise is an unwanted and unpleasant sound that occurs in the wrong place at the wrong time. It can impair hearing, increase stress levels and reduce concentration and work efficiency. In recent years, noise pollution has been rising rapidly. This study aims to assess the extent of noise pollution and its health effects on residents of the Pepsicola area in Kathmandu Valley. A descriptive cross-sectional study design was employed, using a non-probability sampling technique. Sound pressure levels were measured during peak hours using a sound level meter (SL-4010), and data were collected through semi-structured questionnaires administered to 50 respondents across residential, commercial, industrial, traffic and school zones. The findings revealed that average noise levels were highest in industrial areas and lowest in residential zones during both morning and evening periods. Over 60% of respondents demonstrated limited awareness of noise pollution, while 70% reported experiencing significant health effects, including headaches, hypertension and emotional instability. Some of the recorded noise levels exceeded the limits set by both the World Health Organization (WHO) and the Government of Nepal (GoN), indicating a serious public health concern. To mitigate these effects, the study recommends measures such as roadside tree plantations, stricter enforcement of existing noise regulations and the implementation of effective noise reduction strategies.

Keywords: Noise level, Health effects, Mitigation strategies, Public awareness, Pepsicola

Introduction

Noise pollution has now become a significant environmental issue. Any unwanted or excessive sound compromises the natural acoustic environment (Miller, 1998). World Health Organization (WHO) declared noise a pollutant in 1992 (Helgeson & Dread, 2019). As urbanization progresses and the extension of transportation networks continues, the health effects associated with noise pollution increase (Hsu et al., 2012). According to the WHO exposure to noise above 70 dBA could pose a danger to health as a contributor to conditions such as cardiovascular illness, insomnia and cognitive impairment. Reportedly, over 18% of the urban UK population is exposed to harmful noise levels, translating to thousands of premature deaths annually across Europe due to noise-related health problems (Day, 2022).

Noise pollution is not merely a nuisance; at times, it may even have physiological and psychological effects(Muhammad Anees et al., 2017). It leads to increased stress levels due to chronic exposure and raises blood pressure, which lowers quality of life (Anomohanran, 2013). Children are mostly vulnerable to harmful effects of noise in that exposure to environmental noise significantly constrains the process of memory formation in children concerning the weak attention span (Costa et al., 2013). Understanding and avoiding noise pollution helps to promote healthy urban environments. The assessment of noise pollution involves systematic methods of measuring sound levels within different environments wherein tools like sound level meters (Britannica, 2020) and noise mapping techniques are often employed. Sounds produce two characters i.e. frequency and amplitude indicating sound loudness in terms of decibels (dB)

(Morfey, 2021). The decibel scale is logarithmic, meaning each 10 dB increase represents a tenfold increase in sound intensity. To put this into perspective, a sound at 60 dB is one million times more intense than a barely audible sound at 0 dB. This explains why even small increases in decibel levels can have a big impact on noise perception and potential hearing damage (Costa et al., 2013).

Noise pollution has become an important public health concern worldwide; WHO announced that noise exposure above 70 dBA can harm human health severely, causing cardiovascular disease and even cognitive impairment (Clark & Paunovic, 2018). In Nepal, urban centers such as Kathmandu are increasingly faced with noise pollution problems as urbanization advances at a fast rate and traffic grows, notwithstanding a set of regulations put in place to fix noise limits per zone (Pun & Gurung, 2023). At a local level, there are rising noise levels in the Pepsicola area of the Kathmandu Valley because of mixed land use and infrastructure development extending in the area. Noise pollution is a major environmental issue in urban areas, and it's becoming increasingly problematic in rapidly developing cities like the Pepsicola area of Kathmandu Valley. One of the primary sources of urban noise pollution is traffic (Rayamajhi, 2017). To manage noise pollution, Nepal has set standard permissible sound levels for different zones as of the year 2069 B.S. For instance, industrial zones are allowed up to 75 dB during the day and 70 dB at night. In contrast, urban residential areas have stricter limits, with thresholds of 55 dB during the day and 45 dB at night. These regulations aim to protect public health and maintain a livable environment, especially in rapidly urbanizing areas like Pepsicola in Kathmandu Valley (Noise Level Standard of Nepal, 2069). Maintenance levels for silent zones are expected to be 50 dB during the day and 40 dB at night time (Pun & Gurung, 2023).

While Nepal has implemented certain noise control measures such as 'No Horn' zones and area-specific noise limits under the National Sound Quality Standard of 2069 B.S., these regulations are often limited in scope and enforcement (Bhattarai, 2014). For example, although the Kathmandu Valley was declared a no-horn zone in 2017, studies show that compliance and monitoring remain weak. Therefore, comprehensive and enforceable guidelines for noise pollution prevention and control are still lacking, especially in rapidly urbanizing areas like Pepsicola. This study aims to investigate the actual noise levels in the ambient air of the Pepsicola area in Kathmandu Valley, with the goal of contributing to the formulation of more effective noise pollution guidelines. Pepsicola represents a growing concern due to rapid urbanization and increasing traffic, where residential, commercial and industrial land uses coexist. Thus, the main objectives of this study are to measure ambient noise levels, identify primary sources of noise, assess potential health impacts and recommend mitigation strategies. These efforts are intended to enhance understanding of noise pollution and support the development of public health policies in the Kathmandu Valley.

Materials and Methods

Study area

Kathmandu, the capital city of Nepal, spans an area of 395 km² and is surrounded by several municipalities, including Bhaktapur to the east, Kirtipur to the west and Lalitpur to the south. To the north, it is bordered by Nagarjun, Tokha, Tarakeshwor, Budhanilkantha, Gokarneshwor, and Kageshwori Manohara. Due to rapid urbanization and industrial development, Kathmandu faces significant noise pollution, which adversely affects both human and animal health. With an estimated population of 1,471,867 in 2021, the city experiences frequent traffic congestion and occupational noise, particularly during the daytime. Pepsicola, located in Ward No. 32 of Kathmandu, was selected as a study area for assessing noise pollution using a Sound Level Meter. This urban neighborhood lies at the beginning of Bhaktapur Road in the eastern part of Kathmandu, near the Purano Sinamangal Temple and Tribhuvan International Airport. The area derives its name from the nearby Pepsicola factory and spans approximately 0.36 kilometers. Given the area's proximity to major roads and industrial zones, there is a pressing need to investigate noise pollution levels and their health impacts on local residents.

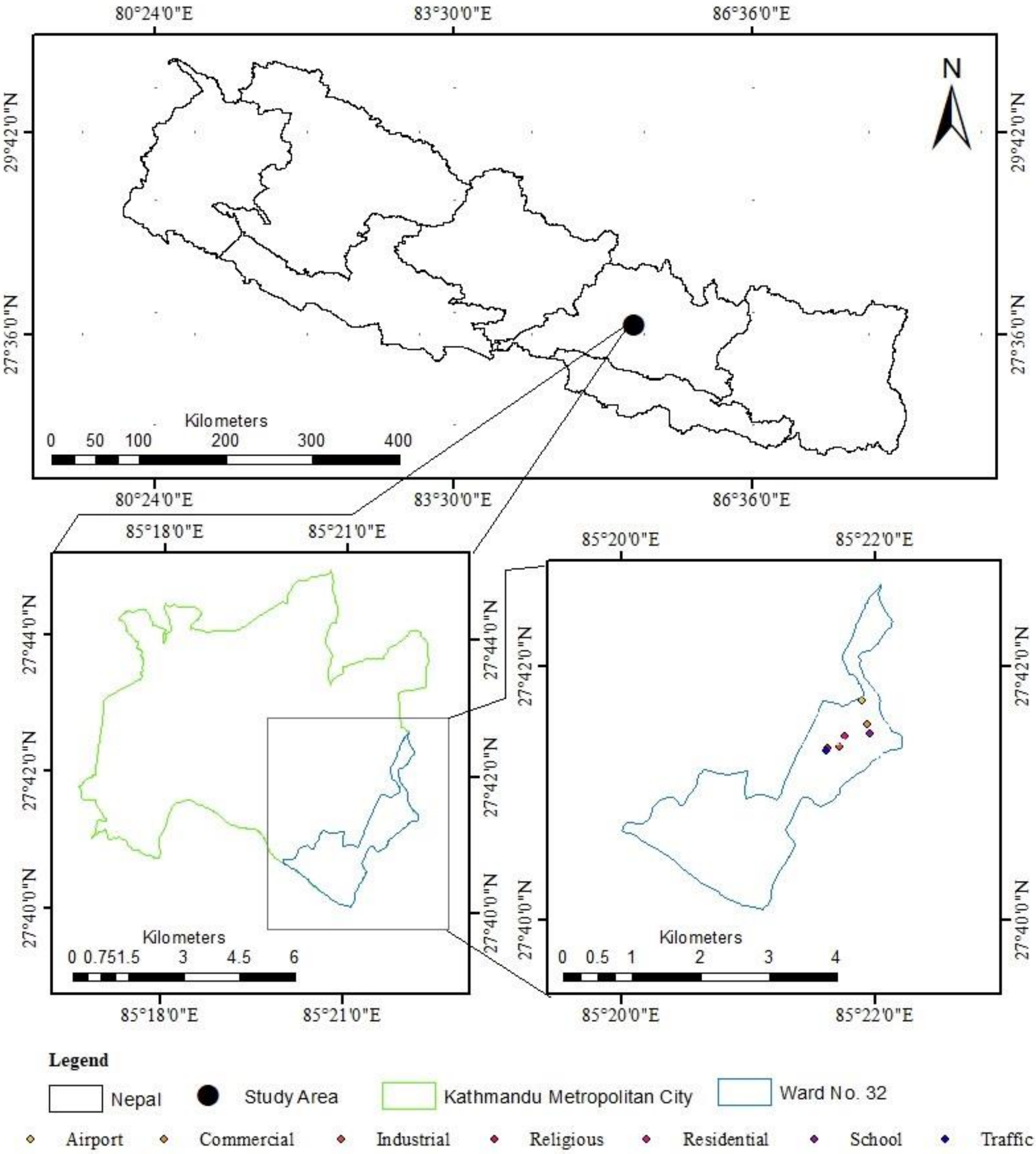

Figure 1: Study Area Map

Sampling Methods

Both primary and secondary data collection methods were employed in this study. The primary data were gathered through field observations, while the secondary data were obtained from published and unpublished journals, reports and official documents.

For the primary data collection, noise levels were measured across seven distinct zones: residential, commercial, industrial, religious, traffic, airport and school areas. A Sound Level Meter (Model SL-4010) was used to monitor the sound pressure levels in these zones. The measurement settings were categorized into three ranges: Range 1: Residential areas; Range 2: Commercial, school, and religious areas; Range 3: Industrial, traffic, and airport areas.

Measurements were conducted from October 13 to November 9, 2022, during two daily time slots: 9:00

to 10:00 AM and 4:00 to 5:00 PM. At each sampling point, sound levels were recorded for one hour, with readings taken every minute and a 2-minute interval between each reading. The sound level meter was positioned at a height of 1.5 meters above ground level. All measurements were taken under calm weather conditions, with no rainfall and typical traffic flow. In addition to field measurements, a questionnaire survey was conducted to assess public perception of noise pollution and its health impacts. A total of 50 respondents from the study area participated in the survey over the course of one month. The survey collected data on individual's experiences and health symptoms related to noise exposure. After data collection, the maximum and minimum noise levels were identified and compared with the standard noise level limits set by the Government of Nepal.

Data Analysis and Interpretation

The primary tool used for data collection was a Sound Level Meter, which measured environmental noise levels across various zones. In addition, a semi-structured questionnaire survey was conducted to gather information on health issues experienced by individuals due to their working environment and exposure to noise pollution. The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25. Various graphs and charts were plotted to visually represent the variables and findings. The responses from the questionnaire were evaluated to determine the knowledge level of participants regarding noise pollution and its health effects. These scores were then interpreted and categorized using a Percentage-Based Grading System.

Formula used was:

$$L_{eq} = 10\mathbf{log}_{10}\left(\frac{N}{1}\sum_{\boldsymbol{i=1}}^{\boldsymbol{N}} \mathbf{10}\,\frac{Li}{10}\right)$$

Results and Discussion

Noise level at different sites in the morning and evening time

Table 1 presents a statistical summary of noise levels recorded during the morning across seven distinct zones. Among these, residential areas had the lowest average noise level at 47.3 dB, ranging from 43.1 to 52.8 dB. In contrast, industrial zones were the loudest and most consistent, with a mean of 93.99 dB, a range of 91.1 to 98.1 dB and the lowest standard deviation of 2.1, indicating stable noise levels. While residential zones remained relatively quiet, the school zone showed notable variability, suggesting a dynamic noise environment likely influenced by student activity. Traffic and airport zones had comparable noise levels, whereas religious areas maintained moderate noise levels within a narrow range (Table 1 and Figure 2).

Similarly, the evening data in Table 1 shows that residential areas continued to be the quietest, with a mean noise level of 46.3 dB (range: 40.6 to 51.6 dB) and a low variability (standard deviation: 2.9). On the other hand, industrial zones recorded the highest evening noise levels, with a mean of 97.3 dB (range: 93.1 to 103.2 dB) and a moderate standard deviation of 3. Religious and airport zones had similar evening noise characteristics, with mean values of 69 dB and 77 dB, and low standard deviations of 2.6 and 2.7, respectively. The school zone again showed the widest variability, with a standard deviation of 6, reflecting fluctuations in noise levels due to student presence during peak hours. Thus, the industrial areas consistently recorded the highest noise levels, followed by airport and traffic zones, while residential and religious zones remained relatively quieter throughout the day.

In the study carried out on Dindigul-Bangalore road (NH-209) by Subramani, Kavitha and Sivaraj (2012), it was found that traffic noise from highways creates problems for surrounding areas, especially when there are high traffic volumes and high speeds but in this study the industrial area shows high noise level, this variations could be due to the different set of environmental conditions (Table 1, Fig. 3).

Table 1: Noise level in different sites

Time	Morning				Evening			
Area	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
Residential area	43.1	52.8	47.3	3.0	40.6	51.6	46.3	2.9
Commercial area	60.5	71.3	66.6	2.8	62.1	72.6	65.9	3.2
Industrial area	91.1	98.1	93.9	2.1	93.1	103.2	97.3	3
Religious area	64.9	73.1	68.2	2.4	65.3	74.1	69	2.6
Traffic area	67.1	81.3	74.2	4	67.7	80.2	72.8	3.7
Airport area	72.3	86.8	76.9	4	72.8	83	77	2.7
School area	63	82.4	68.8	5.3	62.1	81.2	68.8	6

Source: Field Survey, 2022

The recorded data from different areas at different times, with their minimum, maximum, mean, median, and standard deviation, have been tabulated in Table 1.

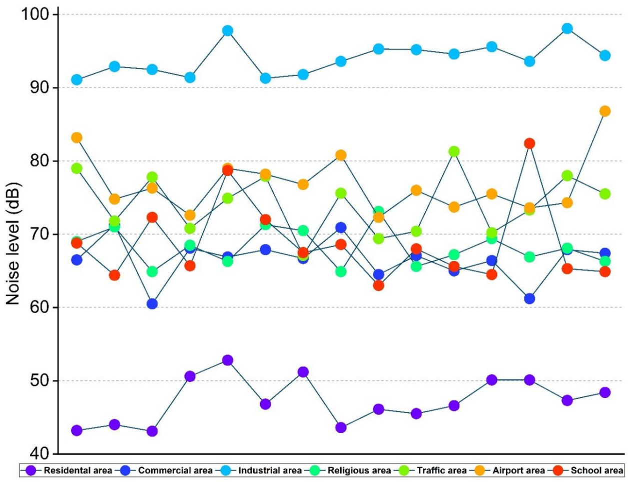

Figure 2: Noise level in different sites at morning time

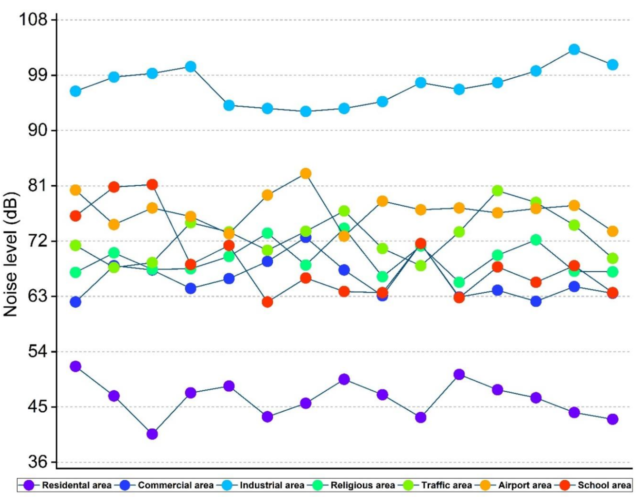

Figure 3: Noise level in different sites at evening time

Comparative data of Noise level during morning and evening time

The comparative data of the noise level during morning and evening time of different zones is presented in Figure 4 and Figure 5.

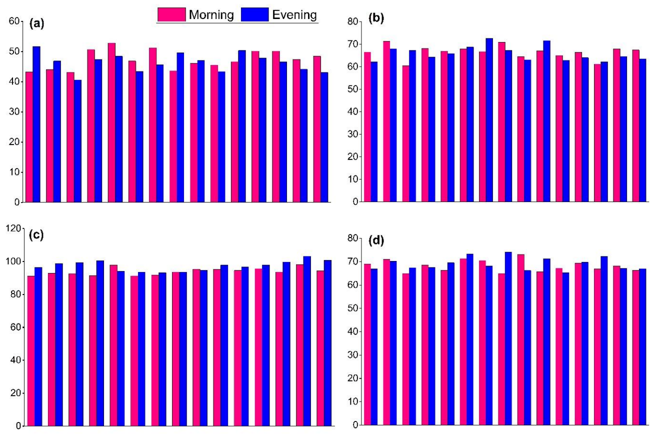

Figure 4: Noise level during morning time of different zones

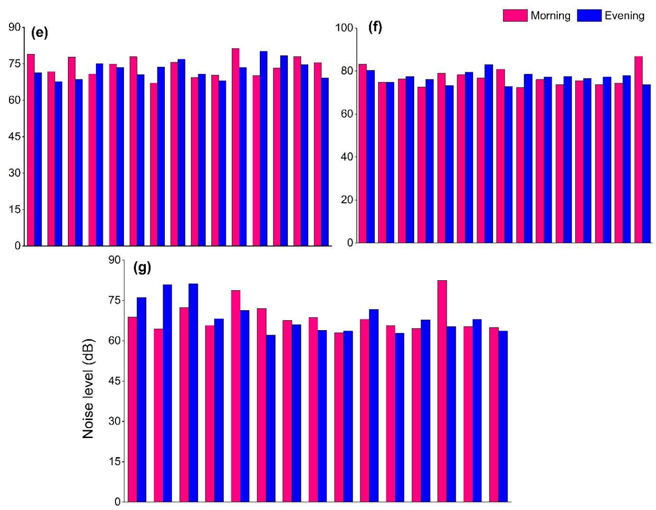

Figure 5: Noise level during evening time of different zones (Field Survey, 2022)

Figure 4 illustrates the noise level status during the morning period, highlighting variations across different zones. In contrast, Figure 5 shows that the sound levels in residential areas during the evening are slightly above the average, indicating relatively low noise exposure compared to other zones. For instance, sound levels in residential areas during the evening showed a slight decline, with the mean dropping from 47.3 dB to 46.3 dB, and the maximum value decreasing from 52.8 dB to 51.6 dB. Additionally, there was a minor reduction in variability, as indicated by the standard deviation decreasing from 3.0 to 2.9. According to the limit set by the WHO standards, there should be a noise level of not more than 50 dB at a school site, 55 dB at a residential site, 65dB at a commercial site, 70 dB at an industrial site (GoN, 2069). However, the observed data were above the limit set by WHO except for residential areas whose highest dB was 52.8dB other than that all other sites have crossed the limit and directly or indirectly affected the health of all living beings. Noise levels at industrial sites in the evening increase tremendously, (mean of 93.9 dB in the morning to over 100 dB during the evening). With this, the standard deviation also increases from 2.1 to 3.0 showing more variation in the evening recordings. Consequently, religious areas show a slight increase in the mean value from 68.2 dB to 69 dB, similar medians and a slight increase in standard deviation (2.4 to 2.6), which indicates more or less uniform levels of noise at any time of the day.

Traffic areas showed average noise reduction from 74.2 dB to 72.8 dB from evening to morning. The maximum and the standard deviation thus show a decline, as this all comes with reduced variation during the night. Overall, while some areas show lesser noise and variability in the evenings, others such as industrial and religious areas show increased noise due to the different activity patterns across these zones. Likewise, the study carried out by Swain and Goswami, (2018) explicitly revealed that the noise levels are more than the permissible limit in all the investigated sites in Bhubaneswar and Puri, Odisha in India. Moreover, it depicts that the transportation sector is one of the major contributors to noise in this city and the average noise level at all sites was found to be above the prescribed limits. In this study, the industrial area consistently recorded the highest noise levels during both morning and evening periods. These levels were found to exceed the permissible limits set by the Government of Nepal, aligning with findings from previous research conducted by other scholars (Chauhan et al. 2021; Swain & Goswami, 2018).

Table 2: level of knowledge on noise pollution among respondents (n=50)

Variables	**Yes**		**No**		**Don't know**			
	Frequency(n)	(%)	Frequency(n)	(%)	Frequency(n)	(%)		
Do you know about the "Noise"?	46	93	2	4	2	4		
Do you consider "Noise" as environmental pollution	11	22	31	62	8	16		
Do you know that Noise affects human health?	45	90	3	6	2	4		
How many hours a day do you spend in this setting?	>3hrs		3-5hrs		>5hrs		Don't know	
	Frequency(n)	(%)	Frequency(n)	(%)	Frequency(n)	(%)	Frequency(n)	(%)
	5	10	15	30	20	40	10	20
What kind of noise do you perceive most in your area?	Yes		No					
	Frequency(n)	(%)	Frequency(n)	(%)				
(a) Traffic Noise	50							
(b) Airplane Noise	20	40	30	60				
(c) Construction Noise	15	30	35	70				
(d) Religious Noise (Bhajan/Bell)			50	100				
(e) Industrial Noise	14	28	36	72				
(f) School Noise	40	80	10	20				
(g) Hospital Noise			50	100				
(h) Crowd	35	70	15	30				
(i) Neighborhoods Noise	10	20	40	80				

Source: Field Survey, 2022

Knowledge regarding the pollution level

The perception of knowledge on the effect of noise level on health collected from 50 residents is presented in Table 3.

Table 3 shows that almost all 92% of the respondents know about "Noise". More than half of the respondents 58% did not know noise caused environmental pollution. Most of the respondents (90%) know that noise causes health effects in humans. Most of the respondents 40% spend more than 5 hours in their particular setting. The majority of the respondents from the traffic area and school area perceived excessive noise at 100% and 80%, respectively. This reveals that more than half of the respondents 60% had inadequate knowledge level about noise pollution, however, they knew about its source. This indicates that there is a lack of awareness among local people residing in the Pepsicola area.

Table 3: Level of Knowledge on Noise Pollution (n=50)

Knowledge Level	Frequency(n)	Percentage (%)
Adequate	20	40
Inadequate	30	60

Table 4 shows that more than half of the respondents (60%) had inadequate knowledge about noise pollution whereas (40%) had adequate knowledge (Table 4).

Health effect of noise pollution

The health effect of noise pollution collected from fifty households is presented in Table 5.

Table 5 shows that the majority of the respondents 90% were free from cardiovascular disease from noise pollution. Most of the respondents 70% were at a medium level of emotional instability. Likewise, 60% of the respondents felt high-level effects from noise and could not hear properly until another person spoke loudly. More than half of the respondents 60% and 80% felt a high level of effect of noise that caused them hypertension and headache, respectively. As in the study of Rahman et al. (2020), 94% of respondents reported headache, 76% sleeplessness, 74% hypertension, 74% physiological stress, 64% elevated blood pressure levels, and 60% dizziness due to noise. This showed that noise is a crucial factor in changing the state of living life. In Table 5 majority of the respondents (60%) were irritated at a medium level and almost all of them were found to suffer from gastrointestinal/stomach problems. Half of the respondents (50%) felt speech disturbance at a medium level. All the respondents felt negligible levels of sleep disturbance and feelings of vomiting. More than half of the respondents felt medium levels of chest pain 60% and dizziness 70%, respectively.

In comparison to the study of Muhammad et al. (2018), it was found that a huge number of the

Table 4: Health effects of noise pollution among respondents (n=50)

Statements	No		High		Medium		Low		Negligible	
	N	%	N	%	N	%	N	%	N	%
Cardiovascular disease	45	90	5	10	-	-	-	-	-	-
Emotional instability	10	20	-	-	35	70	5	10	-	-
Couldn't hear properly until other speaks loudly	10	20	30	60	10	20			-	-
Gets often tired working in noisy areas	-	-	25	50	15	30	10	20	-	-
Hypertension	15	30	30	60	-	-	5	10	-	-
Often headache	-	-	40	80	10	20	-	-	-	-
Gets irritated easily	10	20	10	20	30	60	-	-	-	-
Gastrointestinal/ stomach problem	-	-	50	100	-	-	-	-	-	-
Speech disturbance	15	30	10	20	25	50	-	-	-	-
Sleep disturbance	-	-	-	-	-	-	-	-	50	100
Chest pain	-	-	5	10	30	60	-	-	15	30
Feeling of Vomiting	-	-	-	-	-	-	-	-	50	100
Feeling of Dizziness	15	30	-	-	35	70	-	-	-	-
Make difficulties in concentration	15	30	10	20	-	-	-	-	25	50

Source; Field survey, 2022

population has apparent problems of disturbed sleep, annoyance, low outcomes in the performance of the daily life of industrial persons and an increase of hypertension with another certain cardiovascular disease. Likewise, results from the study conducted by Agarwal and Swami (2011) reported that road traffic was the major source of noise in the area. Results of a health survey reported that about 52% of subjects were suffering from frequent irritation, 46% had hypertension, 48.6% reported difficulties in sleep due to traffic noise and females were more sensitive to noise-related health problems. These findings are in line with similar studies in urban India and other South Asian cities, where industrial and transportation sectors are major contributors to excessive noise pollution (Sahu et al., 2020; Pun & Gurung, 2023).

Table 5: Level of respondents view on effects of health from noise pollution (n=50)

Health effect Score	Frequency(n)	Percentage (%)
Maximum	35	70
Minimum	15	30

Table 6 indicates that a significant majority of respondents (70%) reported experiencing substantial health effects due to noise pollution. This suggests that noise pollution is a major concern for residents, particularly in the Pepsicola area of the Kathmandu Valley. Although Nepal has implemented certain noise control measures such as designated no-horn zones and area-specific noise limits, the absence of comprehensive and consistently enforced regulations likely contributes to the frequent surpassing of safe noise thresholds (Pun & Gurung, 2023).

Conclusion

This study underscores that noise pollution in the Pepsicola area of Kathmandu frequently exceeds both national and international permissible limits, particularly in industrial zones and high-traffic corridors. Residents working in or living near these areas reported a range of health issues most notably headaches, gastrointestinal disturbances, hypertension, and irritability attributed to prolonged exposure to elevated noise levels. Despite the severity of the issue, public awareness remains low, with a majority of respondents lacking sufficient knowledge about noise pollution and its health implications.

These findings highlight the urgent need for targeted public awareness campaigns, stricter enforcement of existing noise control regulations, and the implementation of mitigation strategies such as urban zoning, installation of sound barriers, and roadside tree plantations. However, the study is limited by its data collection scope, which was restricted to peak hours due to COVID-19 constraints, preventing comprehensive all-day monitoring. Future research should incorporate long-term noise surveillance, individual exposure assessments, and more detailed health evaluations to better quantify risks and guide effective policy interventions.

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