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SOUND AND SILENCE: A COMPARATIVE STUDY OF NOISE POLLUTION IN SHIMLA'S RESIDENTIAL AND COMMERCIAL SECTORS, HIMACHAL PRADESH, INDIA

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ABSTRACT. Noise pollution is a growing global issue, impacting both developed and developing countries, including India. Shimla, a historically significant city and a popular hill station in Himachal Pradesh, is experiencing increasing noise pollution due to its expanding population, more vehicles, congested roads, and tourists. This study evaluates noise pollution in Shimla's commercial and residential areas, comparing current levels with Central Pollution Control Board (CPCB) standards and proposing mitigation measures. Noise was measured using a Metravi (SL-4010) sound level meter, with readings taken every three minutes for three hours in the morning, at noon, and in the evening. The equivalent continuous noise level (Leq) was calculated and compared to standards. Measurements were conducted in March and April 2024 at 15 locations. Additionally, a survey of 100 people assessed the causes and effects of noise pollution. Results showed that the Leq dB(A) values ranged from 76.87 dB(A) at Boileauganj Chowk to 84.97 dB(A) at the Old Bus Stand in commercial areas. In residential areas, Khalini Chowk recorded the highest Leq of 80.56 dB(A), while Mall Road had the lowest at 76.87 dB(A). Vehicles were identified as the primary noise source by 75% of respondents. In the survey, 51.67% of respondents reported irritation due to high noise levels, and 38.33% experienced headaches, highlighting the adverse effects on residents' well-being and health. All locations exceeded CPCB standards for noise levels. The study recommends measures to reduce noise pollution in Shimla and suggests further comprehensive noise pollution studies in Himachal Pradesh.

Keywords: commercial area; noise pollution; residential area; shimla.

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INTRODUCTION

Noise pollution is a disruptive, harmful sound that negatively impacts human health and well-being. According to the World Health Organization, noise levels above 65 decibels (dB) are considered noise pollution. It is recognized as a leading environmental health risk, affecting people of all ages and social groups, thereby increasing the overall public health burden. The patterns of sound greatly influence both the physical and psychological impacts on listeners (Basner *et al.*, 2015).

Urban noise pollution is dependent on various factors, including transportation (road, rail, air), industrial activities, construction, music concerts, public address systems, and loudspeakers at events such as weddings and religious gatherings (Banerjee, 2012; Vijay *et al.*, 2015). Indoors, noise sources include everyday activities and appliances such as kitchen devices like blenders and mixers, electronic gadgets, footsteps, conversations, home appliances, and office equipment, all contributing to indoor noise pollution. These indoor noises, combined with outdoor sounds, often exceed recommended noise limits (Hunashal and Patil, 2012). During their mating season, cicadas produce loud buzzing or clicking sounds, while crickets add to ambient noise with their rhythmic chirping, especially in large numbers. Additionally, during breeding seasons, frogs can create noise pollution with their loud croaking, particularly in areas with dense frog populations. Mammals like dogs also contribute to urban and suburban noise through barking or howling. Noise pollution negatively impacts all living organisms.

The impact of noise, especially on human health and comfort, depends on its duration and volume. While occupational exposure is the leading cause of hearing loss, recreational noise can also result in significant hearing damage. Research shows that children are more vulnerable to noise-induced hearing impairment than adults (Berglund and Lindvall, 1995). The consequences of hearing loss include loneliness, depression, difficulty in understanding speech, reduced performance in school and work, limited job opportunities, and a sense of isolation (Passchier-Vermeer and Passchier, 2000). Noise pollution and its associated health effects are becoming increasingly common, leading to both short-term and long-term psychological and physiological illnesses (Garg *et al.*, 2017).

Globally, noise pollution is recognized as a major concern affecting urban quality of life, predominantly due to vehicular traffic (Suksaard *et al.*, 1999; Zannin *et al.*, 2002). The necessity to study urban noise pollution and its environmental effects has led to numerous research activities globally (Zannin *et al.*, 2003; Zeid *et al.*, 2000). Surveys conducted in various cities around the world have highlighted the level of discomfort caused by noise in people's daily lives (Alberola *et al.*, 2005; Bhosale *et al.*, 2010), pointing out its significant impact (Marius *et al.*, 2005; Vidyasagar and Rao, 2006).

In India, many cities are dealing with serious noise pollution issues because there are more vehicles now, roads have expanded, industries have grown, and cities have developed a lot in the past few decades (Singh *et al.*, 2013). Researchers have investigated noise pollution in different cities like Lucknow (Srivastava and Rai, 2020), Nagpur (Vijay *et al.*, 2015), Allahabad (Kumar *et al.*, 2013), Gorakhpur (Singh and Pandey, 2013), Mumbai (Joshi *et al.*, 2015), and Varanasi (Pathak *et al.*, 2008), among others.

The present study was conducted in Shimla, the capital city of Himachal Pradesh and a prominent tourist destination, where limited research has been conducted on noise pollution. Since the launch of the Smart City Mission by the Central Government in 2015, Shimla has experienced significant population growth and an increase in vehicles, leading to road congestion and affecting urban mobility. Noise pollution is also becoming more prevalent in Shimla, particularly due to the presence of major government centers, institutions, colleges, and universities and the influx of tourists. This noise pollution has various impacts on the city's residents. This study aims to evaluate noise pollution levels in both commercial and residential areas of Shimla, analyze the current situation with CPCB standards as shown in *Table 1*, and propose mitigation measures.

MATERIALS AND METHODS

Noise measurements were conducted using the Metravi (SL-4010) sound level meter made by Metravi Instruments. It is a type 2 instrument designed to meet the measurement requirements of safety engineers, health, industrial safety offices, and sound quality control in various environments. The meter has a range from 30 dB to 130 dB at frequencies between 31.5 Hz and 8 kHz, with display options in 0.1 dB steps on a four-digit LCD. It features two equivalent weighted sound pressure levels, A and C. Measurements were taken at 15 sites (as shown in *Table 2 and 4*), including commercial zones, residential areas, road crossings, and chowks, during peak traffic hours on working days and weekends, spanning morning (8:00 AM – 11:00 AM), afternoon (1:00 PM – 4:00 PM), and evening (5:00 PM – 8:00 PM) sessions. Readings were recorded every 3 minutes for 3 hours. The measurements took place in March and April 2024 in Shimla city, with ambient sound levels compared to the prescribed standards of the Central Pollution Control Board (CPCB), India.

Table 1 – Ambient air quality standards with respect to noise

Area code	Category of area / zone	Limits in the dB(A) Leq *	
		Day time	Night time
A.	Industrial area	75	70
B.	Commercial area	65	55
C.	Residential area	55	45
D.	Silence zone	50	40

Daytime shall mean from 6.00 AM to 10.00 PM; nighttime shall mean from 10.00 PM to 6.00 AM; mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority; *dB(A) Leq denotes the time-weighted average of the level of sound in decibels on scale A which is relatable to human hearing; A "decibel" is a unit in which noise is measured; "A", in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear; Leq is an energy means of the noise level over a specified period.

The formula is represented by the following (*Equation 1*):

$$Leq = 10\, log \sum_{i=1}^{i=n} 10^{Li\backslash 10}\, X\, ti \quad (1)$$

where Li is the noise level of any ith sample; n is the total number of sound samples; and ti is the time duration of the ith sample, expressed as a fraction of the total sample time.

To thoroughly investigate noise pollution in Shimla's residential and commercial areas, a detailed survey was conducted with 100 residents selected randomly to represent a broad cross-section of the city. The survey used a well-structured questionnaire with both multiple-choice and open-ended questions. Multiple-choice questions were used to gather quantifiable data on noise pollution sources and their impacts. Residents were asked to choose from predefined options to identify common noise sources like traffic or construction and to report how often they encountered these noises. They also rated how noise affects their daily lives, such as causing stress or disrupting sleep. This provided clear information about the extent and frequency of noise problems. Open-ended questions allowed residents to provide more detailed and personal feedback. They could describe additional noise sources not listed, explain how noise affects their well-being and daily routines, and suggest ways to reduce noise pollution. This part of the survey offered deeper insights into individual experiences and challenges. Combining both types of questions allowed for a comprehensive understanding of noise pollution in Shimla. The multiple-choice questions provided statistical data on general trends, while the open-ended responses offered a more detailed view of personal impacts and potential solutions.

RESULTS

In commercial areas

In the morning hours (8–11 AM), the Old Bus Stand and Victory Tunnel registered the highest noise levels at 84.59 dB(A) and 84.46 dB(A), respectively, while Boileauganj Chowk recorded the lowest at 75.61 dB(A). During the noon period (1–4 PM), the noise peaked at the Old Bus Stand at 85.02 dB(A), followed by Victory Tunnel at 84.26 dB(A), and Boileauganj Chowk remained the quietest at 74.12 dB(A). In the evening, the Old Bus Stand once again topped the noise charts with 86.08 dB(A), followed by Victory Tunnel at 85.18 dB(A), while Boileauganj Chowk maintained its position as the quietest spot at 79.07 dB(A) as shown in *Table 2*.

If we talk about the Leq, throughout the entire day, the Leq dB(A) values ranged from 76.87 dB(A) at Boileauganj Chowk to 84.97 dB(A) at the Old Bus Stand. This indicates consistently high noise levels at the Old Bus Stand, while Boileauganj Chowk experienced relatively lower noise levels on average, as shown in *Table 3*.

Residential-turned-commercial areas

Noise levels in Shimla's residential-turned-commercial area exceeded prescribed limits. During morning hours, Sanjauli Chowk recorded the highest noise at 79.9 dB(A), followed by Khalini Chowk at 78.46 dB(A), while Mall Road was the quietest at 65.44 dB(A). In the noon period, Totu Chowk had the highest noise at 80.79 dB(A), Khalini Chowk closely followed at 79.86 dB(A), while

Mall Road remained the quietest at 69.22 dB(A). The evening saw Khalini Chowk recording the highest at 82.42 dB(A) and Sanjauli Chowk at 80.29 dB(A), while Mall Road was still the quietest at 71.39 dB(A), as shown in *Table 4*.

Table 2 – The values of noise in dB(A) in the commercial area of Shimla city in three time slots

Sr. No.	Locations	Latitude (degrees (°), minutes (′), seconds (″)).	Longitude (degrees (°), minutes (′), seconds (″)).	Morning 8–11 AM measured in dB(A)	Noon 1–4 PM measured in dB(A)	Evening 5–8 PM measured in dB(A)
1.	Railway Station	31° 6' 9" N	77° 9' 36.36" E	83.54	82.73	79.88
2.	Summer Hill Chowk	31° 6' 43.2" N	77° 8' 13.2" E	77.14	74.12	81.14
3.	Victory Tunnel	31° 6' 17.316" N	77° 10' 12" E	84.46	84.26	85.18
4.	ISBT	31° 5' 53.88" N	77° 9' 3.24" E	76.27	76.45	78.92
5.	Boileauganj Chowk	31° 5' 58.92" N	77° 8' 20.4" E	75.61	74.57	79.07
6.	MLA Crossing	31° 6' 1.638" N	77° 8' 30.3432" E	78.92	78.37	79.52
7.	Old Bus Stand	31° 6' 13.32" N	77° 10' 4.8" E	84.59	85.02	86.08

ISBT = Inter State Bus Terminus; MLA Crossing = Member of Legislative Assembly Crossing

Table 3 – The Leq (dB(A)) of the selected commercial area of Shimla city

Sr. No.	Location	Leq 8 AM–8 PM measured in dB(A)	Noise standard in commercial area measured in dB(A)
1.	Railway Station	82.31	65
2.	Summer Hill Chowk	78.4	65
3.	Victory Tunnel	84.65	65
4.	ISBT	77.39	65
5.	Boileauganj Chowk	76.87	65
6.	MLA Crossing	78.96	65
7.	Old Bus Stand	84.97	65

ISBT = Inter State Bus Terminus; MLA Crossing = Member of Legislative Assembly Crossing

Table 4 – The values of noise in dB(A) in residential-turned-commercial areas of Shimla city in three time slots

Sr. No.	Location	Latitude (degrees (°), minutes (′), seconds (″)).	Longitude (degrees (°), minutes (′), seconds (″)).	Morning 8–11 AM measured in dB(A)	Noon 1–4 PM measured in dB(A)	Evening 5–8 PM measured in dB(A)
1.	Mall Road	31° 6' 12.6" N	77° 10' 12.72" E	65.44	69.22	71.39
2.	Lakkar Bazar	31° 6' 21.6" N	77° 10' 44.4" E	67.73	75.63	78.75
3.	Sanjauli Chowk	31° 6' 13.68" N	77° 11' 34.44" E	79.9	78.59	80.29
4.	Panthaghati	31° 4' 14.88" N	77° 10' 48.36" E	76.07	74.92	79.06
5.	Secretariat, Chota Shimla	31° 5' 16.404" N	77° 10' 51.6" E	76.93	77.77	79.22
6.	Khalini Chowk	31° 5' 24" N	77° 10' 19.2" E	78.46	79.86	82.42
7.	Totu Chowk	31° 5' 57.012" N	77° 7' 43.68" E	78.29	80.79	80.16
8.	Ridge	31° 6' 17.28" N	77° 10' 28.92" E	68.92	69.45	72.51

The equivalent continuous noise level (Leq dB(A)) for the entire day showed Khalini Chowk recording the highest Leq of 80.56 dB(A), while Mall Road had the lowest at 76.87 dB(A). Khalini Chowk consistently exhibited higher noise levels compared to other locations, indicating persistent noise pollution, while Mall Road maintained relatively lower noise levels, as shown in *Table 5*.

Table 5 – The Leq (dB(A)) of the selected residential-turned-commercial area of Shimla city

Sr. No.	Location	Leq 8AM-8P.M measured in dB(A)	Noise standard in residential area: measured in dB(A)
1.	Mall Road	69.32	55
2.	Lakkar Bazar	75.93	55
3.	Sanjauli Chowk	79.65	55
4.	Panthaghati	77.05	55
5.	Secretariat, Chota Shimla	78.08	55
6.	Khalini Chowk	80.56	55
7.	Totu Chowk	79.87	55
8.	Ridge	70.6	55

People's perception of the cause of noise pollution

According to survey findings, vehicles were identified as the primary source of noise pollution by 75% of respondents.

Other notable contributors included public noise (43%), loudspeakers (28.3%), construction activities (28.3%), animal sounds (21.67%), appliances and machinery (16.67%), weddings and parties (11.67%), religious events (6.67%), and miscellaneous sources (13.33%), as illustrated in *Figure 1*.

People's perception of the problems they face due to noise pollution

A survey conducted in Shimla city regarding the impacts of noise pollution found that 51.67% of respondents reported experiencing irritation, followed by headaches at 38.33% and insomnia at 35%. Approximately 25% of respondents indicated either no problems or a habituation to noise. Communication disruptions affected 18.3% of respondents, while 13.35% experienced performance issues. Hypertension was reported by 5%, and hearing loss by 3.3%, as depicted in *Figure 2*.

People's perception of noise pollution on different weekdays

In Shimla, a survey revealed Monday was the busiest day, with 75.67% of respondents perceiving it as the noisiest. Following closely, Saturday was identified by 61.67% of participants, while Tuesday stood out for 51.67%. Wednesday, Thursday and Friday were equally noted by 48.3% of respondents for noise pollution. Sunday emerged as the quietest day, with fewer respondents reporting noise issues, as shown in *Figure 3*.

DISCUSSION

Commercial area

The data in *Table 2* and *Table 3* show Shimla Railway Station's noise environment is dynamic, with peaks during train arrivals and departures, primarily due to train horns, and quieter periods when no trains are present. This variability highlights the significant impact of train operations on the station's noise levels.

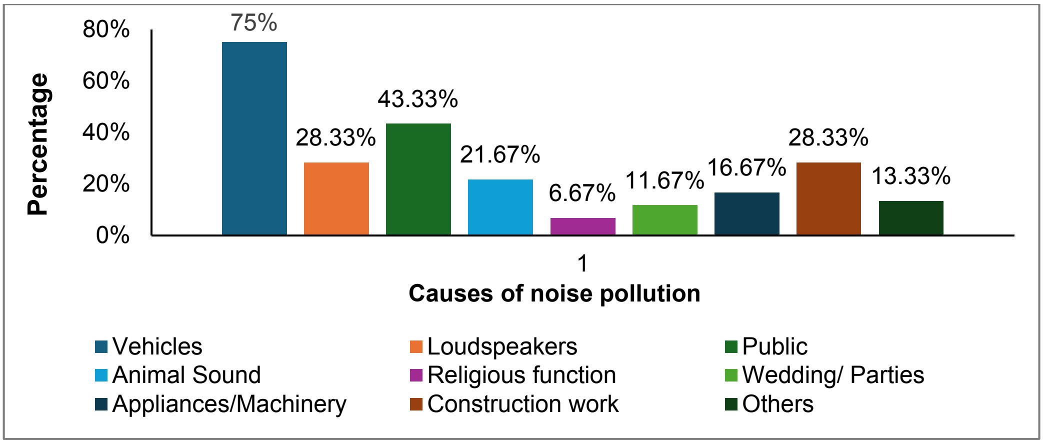

Figure 1 – People's perception of the cause of noise pollution in Shimla city

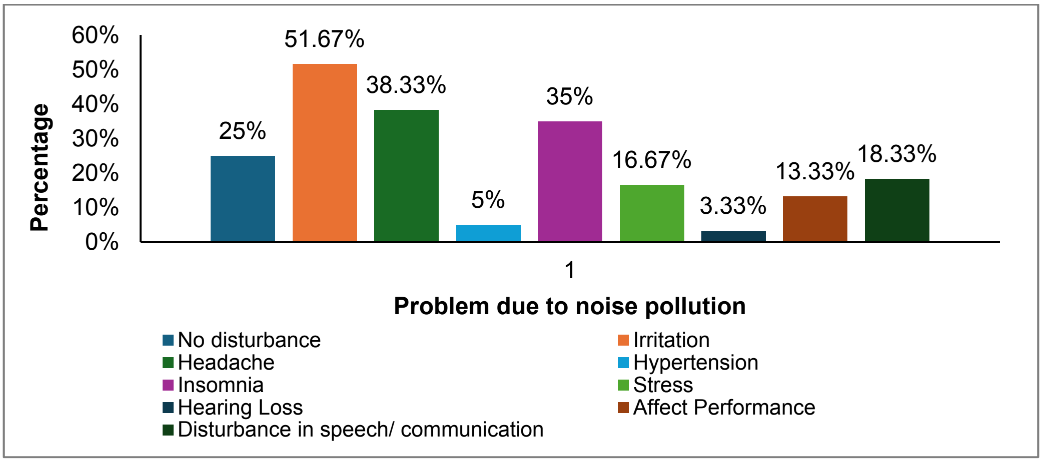

Figure 2 – People's perception regarding problems they face due to noise pollution in Shimla city

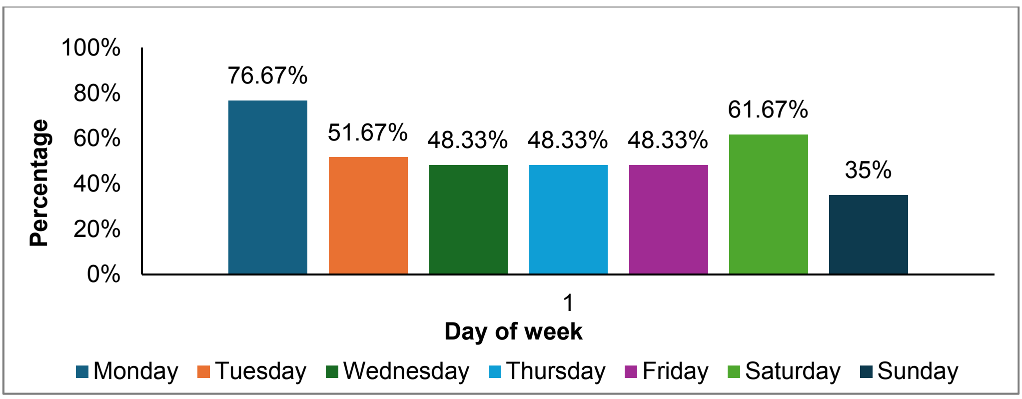

Figure 3 – The days of the week when respondents considered noise pollution in Shimla city

Shimla's railway station noise level of 82.31 dB(A) is comparable to Tirupur City's railway station, where Keerthana *et al.* (2013) recorded 82 dB.

Summer Hill Chowk is a dynamic area characterized by significant noise variations due to its multifaceted environment. The primary sources of noise include vehicular engines, horns, and public activities. The nearby presence of Himachal Pradesh University contributes to the overall noise of the environment. Noise levels ranging from 70.17 dB to 87.89 dB in Gorakhpur city's Ganesh Chowk, as measured by Singh and Pandey (2013), are similar to the 78.4 dB(A) recorded in Summer Hill Chowk.

The Victory Tunnel, situated at a busy road junction, experiences consistently high noise pollution with an overall Leq of 84.65 dB(A). Noise levels peak during heavy traffic periods, especially in the evening, reflecting its role as a major traffic conduit. Noise levels at Victory Tunnel (84.65 dB(A)) are within the range of 80.26 dB to 92.3 dB found in Salem city by Thangadurai *et al.* (2005).

The Inter-State Bus Terminal (ISBT) is an important bus terminal in Shimla, serving as a major hub for interstate and long-route bus services. It is located outside the city center, leading to quieter and more consistent noise levels with an average of 77.39 dB(A). It operates in an organized manner, unlike the bus stands, which can be chaotic. However, during peak hours, noise levels can spike occasionally. Compared to the new bus stand in Tirupur city, which has noise levels ranging from 82 dB to 94.31 dB, according to a study by Keerthana *et al.* (2013), ISBT's noise levels are lower.

Boileauganj Chowk in Shimla is a key intersection that serves as a major gateway connecting different neighborhoods and commercial areas in the city. It sees high noise levels during rush hours, peaking at 79.07 dB(A) in the evening and averaging 76.87 dB(A) overall. Noise levels drop to 74.57 dB(A) during quieter noon periods, reflecting the area's continuous traffic flow and related noise fluctuations. Noise levels at Boileauganj Chowk (76.87 dB(A)) are comparable to the range of 62.8 dB to 109.3 dB found in Angul, Odisha by Pradhan *et al.* (2012).

MLA Crossing is a busy junction connecting Shimla with Solan, Chandigarh, and local routes, and it is experiences high noise levels due to continuous vehicular traffic. Noise peaks at 78.92 dB(A) in the morning and 79.52 dB(A) in the evening, with a slight dip to 78.37 dB(A) during quieter noon hours. The overall noise level averages 78.96 dB(A), reflecting persistent traffic-induced noise fluctuations throughout the day. Noise levels at MLA Crossing (78.96 dB(A)) fall within the range of 63.2 dB to 99.7 dB at important road intersections in Salem city by Thangadurai *et al.* (2005).

The Old Bus Stand in Shimla is a noisy and congested transit hub with persistent high noise levels, peaking at 101.4 dB(A) due to heavy traffic and constant activity. Its elevated noise levels are driven by tight parking conditions and frequent horn use throughout the day. Shimla's Old Bus Stand (84.97 dB(A)) showed a lower noise level compared to Tirupur city's old bus stand (89–95.37 dB), as reported by Keerthana *et al.* (2013).

Residential-turned-commercial area

Table 4 and *Table 5* show that Mall Road, the city's main commercial hub, is frequented by both locals and tourists. Despite its restricted vehicle access, which aims to manage noise, it exhibits a daily average noise level of 69.32 dB(A), with a range from 60.4 dB to 88.7 dB. This level is comparable to other urban areas; for instance, Singh and Dadoriya (2004) recorded residential noise in Morena city between 68.1 dB and 75.8 dB, while Chauhan and Pande (2010) found higher ranges in Dehradun, from 55.3 dB to 107.6 dB.

Lakkar Bazar, known for its wooden artifacts and bustling marketplace, also experiences high noise levels, with a daily average of 75.93 dB(A) and a range from 59.4 dB to 101.1 dB. This area's noise levels are elevated compared to other regions, such as Asansol, where Banerjee and Chakraborty (2006) observed ranges from 53.6 dB to 76.8 dB, and Dehradun, which Chauhan and Pande (2010) found to reach up to 107.6 dB.

Sanjauli Chowk, a vibrant area integrating residential and commercial zones with a college, has noise levels that are notably high. The daily average is 79.65 dB(A), with a range of 69.4 dB to 97.5 dB. This level reflects a busier environment compared to other locations, aligning with findings by Chauhan and Pande (2010) and Singh and Pandey (2013) in Dehradun and Gorakhpur, respectively.

Panthaghati, a quieter residential area situated farther from major roads, records a daily average noise level of 77.05 dB(A) and a range from 65.8 dB to 98.7 dB. This level is relatively high for a residential zone and is similar to the findings of Chauhan and Pande (2010) and Singh and Pandey (2013) in other residential areas.

Secretariat, Chotta Shimla, which combines residential areas with administrative buildings, shows a daily average noise level of 77.05 dB(A) with a range of 58 dB to 96.1 dB. The noise levels are influenced by both residential and administrative activities, reflecting a mid-range noise profile compared to other studied areas.

Khalini Chowk, located in a residential area, experiences notable noise due to its steep slope and heavy vehicular activity, including local and long-distance buses. It has a daily average noise level of 80.56 dB(A) and a range from 67.9 dB to 99.3 dB. These findings are comparable to the higher end of noise levels documented in Dehradun by Chauhan and Pande (2010) and Gorakhpur by Singh and Pandey (2013), reflecting the complex interplay of traffic and geographical factors.

Totu Chowk in Shimla is a bustling traffic junction known for its vibrant commercial activity and connectivity to various parts of the city and residential area. It exhibits a daily average noise level of 79.87 dB(A) and a range from 58 dB to 99.9 dB. The high traffic and activity levels contribute to its elevated noise levels, like those found in Dehradun and Gorakhpur by Chauhan and Pande (2010) and Singh and Pandey (2013), respectively.

Ridge, a popular tourist destination known for its historical significance and scenic views, has a daily average noise level of 70.6 dB(A), with a range of 53.4 dB to 83.3 dB. Despite its heavy tourist traffic, its noise levels are somewhat lower compared to other commercial areas, reflecting a less intense urban environment.

People's perception of the cause of noise pollution

The findings of the study shown in *Figure 1*. were supported by studies of Zannin *et al.* (2003), who discovered that traffic accounted for 73% of noise in a Brazilian city. Similarly, Basner *et al.* (2015) also highlighted occupational and transport noise as significant health impacts. Balashanmugam *et al.* (2013) in Chidambaram, Mirsanjari and Zorufchin (2012) in Tehran, and Agarwal and Swami (2011) in Jaipur attributed excessive noise primarily to vehicular traffic. This study, which was conducted in Shimla, yielded comparable results regarding noise pollution sources. Our study was supported by Vijay *et al.* (2015) in Nagpur, who identified honking, road design, and vehicle speed as significant factors influencing noise levels beyond just traffic volume. Similarly, Wani and Jaiswal (2010) in Gwalior and Firdaus and Ahmad (2010) in Delhi pinpointed traffic congestion, poorly maintained vehicles, and rapid urbanization as major contributors to noise pollution.

People's perception of problems they face due to noise pollution

The impact of noise is shown in *Figure 2*. These findings are supported by Banerjee and Chakraborty (2006), who found that 39% of individuals in Asansol were highly annoyed by noise pollution. Similarly, Wani and Jaiswal (2010) in Gwalior and Mirsanjari and Zorufchin (2012) in Tehran reported significant annoyance and irritation among residents due to traffic noise. Agarwal and Swami (2011) found that 48.6% of Jaipur residents had trouble sleeping due to traffic noise. Similarly, Firdaus and Ahmad (2010) in Delhi identified irritation, sleep disturbances, and communication problems as major issues caused by noise pollution. Our study was supported by these works. A 5 dB increase in roadside noise is linked to a 0.17% higher risk of hypertension and a 0.38% higher risk of heart disease (Oh *et al.*, 2019), illustrating its impact on cardiovascular health. Road traffic noise has also been associated with an increased risk of gestational diabetes mellitus, which can disrupt glucose metabolism early in pregnancy, potentially harming both the mother and foetus (Ashin *et al.*, 2018). Vulnerable populations, including children, the elderly, and individuals with depression, are particularly affected by noise due to their limited coping mechanisms. Children exposed to high noise levels often experience diminished quality of life and increased annoyance (Basner *et al.*, 2014). Yamin *et al.* (2021) found that high noise exposure from tractor implements is strongly correlated with increased depression, aggression, anxiety, and stress in operators, negatively affecting their social interactions compared to office workers.

People's perception of noise pollution on different weekdays

According to the survey, as shown in *Figure 3*, noise pollution peaks on Monday, with 71.67% of respondents affected due to the influx of people returning to work, and on Saturday at 61.67% as people head home. Sundays had lower noise levels (35%), likely due to fewer commercial activities, though residential areas may still experience disturbances. Sundays were noisier in residential-turned-commercial areas. This finding was supported by Kuhlmann *et al.* (2023), who found increased annoyance from sports facility noise on weekends in Germany, which was attributed to more people being at home.

The study on Shimla's noise pollution has key strengths and limitations. It provides a comprehensive view by covering various urban areas and comparing noise levels with cities like Dehradun and Gorakhpur using similar methods to those used by Singh and Pandey (2013) and Thangadurai *et al.* (2005). The inclusion of public perceptions enriches the analysis and reflects issues like sleep disturbances, similar to the findings of Wani and Jaiswal (2010). Temporal analysis of noise patterns adds depth and follows approaches by Kuhlmann *et al*. (2023). However, short-term data collection may miss seasonal and long-term trends, and fixed-point measurements might not capture spatial variability, as noted by Chauhan and Pande (2010) and Singh and Pandey (2013). Limited sample sizes and perception biases may affect generalizability, as discussed by Basner *et al.* (2015). Future research should include longitudinal studies, GIS analysis, health data integration, and policy improvements to address noise impacts effectively.

CONCLUSIONS

Shimla, the most populous city in Himachal Pradesh, faces significant challenges related to congestion and urbanization, leading to various forms of pollution, including noise pollution. This study represents the first examination of noise pollution in Shimla city, focusing on both commercial and residential areas and comparing the findings with the CPCB standards.

The results reveal that noise levels in most of the selected locations exceed the limits set by the pollution control board, with vehicles being identified as the primary source of noise. Contributing factors include the influx of tourists, the presence of major government offices, the high volume and condition of vehicles, and congested road networks. Additionally, noise levels were notably higher on working days, causing significant irritation for approximately half of the respondents. The study suggests that further research is needed to assess noise pollution levels in other cities across Himachal Pradesh to gain a comprehensive understanding of the issue.

Recommendations to reduce noise pollution

- Construct noise barriers along major roads to reduce noise levels. The prototype green noise barrier in Malaysia, utilizing materials like coconut coir and *Ficus pumila*, effectively reduced noise by 13 dB while addressing traditional barrier issues (Ahmad *et al.,* 2023).
- Implement regulations to minimize honking and ensure smooth traffic flow. A horn ban cuts traffic noise by 7–10 dBA (Ali and Tamura, 2003).
- Encourage EV adoption through incentives and infrastructure. Electrifying the entire bus fleet could reduce traffic noise by up to 4.4 dB(A), benefiting 80% of the population (Tsoi *et al.,* 2023).
- Separate noisy commercial areas from quiet residential zones.

- Increase green spaces and vegetation, which can be used as natural sound absorbers. Residential greenery alleviates noise annoyance, improving home satisfaction (Dopico *et al.*, 2023).
- Upgrade building materials and construction practices. Use noise-reducing materials and methods in construction. Adewale and Stephanie (2022) found that integrating noise control strategies in urban design effectively mitigates external noise impacts and supports sustainability in Lagos State.
- Promote community awareness and involvement. Run public education campaigns and encourage community participation.
- Construct flyovers and pedestrian bridges and implement smart traffic management to alleviate congestion and reduce horn use.

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REFERENCES

Adewale, B.A.; Stephanie, M. Investigation of the impact of noise control strategies in sustainable building design. *3rd International Conference on Energy and Sustainable Environment.* **2022**, 1054, 012033. https://doi.org/10.1088/1755-1315/1054/1/012033

Agarwal, S.; Swami, B.L. Road traffic noise, annoyance, and community health survey - a case study for an Indian city. *Noise Health.* **2011**, 13, 272-276. https://doi.org/10.4103/1463-1741.82959

Ahmad, Z.; Mohammad Azizi, K.A.Q.; Mohammed Sukeri, R.A.; Kalai Arasu, S. The effectiveness of green noise barrier for noise reduction. *Jurnal Amalan Pengajaran dan Penyelidikan Lestari.* **2023**, 1, 10-16.

Alberola, J.; Flindell, H.; Bullmore, J. Variability in road traffic noise levels. *Applied Acoustics.* **2005**, 66, 1180-119. https://doi.org/10.1016/j.apacoust.2005.03.001

Ali, S.A.; Tamura, A. Road traffic noise levels, restrictions, and annoyance in Greater Cairo, Egypt. *Applied Acoustics.* **2003**, 64, 815-823. https://doi.org/10.1016/S0003-682X(03)00031-8

Ashin, M.; Bilkenko, N.; Friger, M.; Sergienko, R.; Sheiner, E. 986: Is exposure to traffic noise associated with the development of gestational diabetes mellitus? *American Journal of Obstetrics and Gynecology.* **2018**, 218. https://doi.org/10.1016/j.ajog.2017.11.523

Balashanmugam, P.; Ramanathan, A.R.; Nehrukumar, V.; Balasubramaniyan, K. Assessment of noise pollution in Chidambaram town. *International Journal of Research in Engineering Technology.* **2013**, 2.

Banerjee, D. Research on road traffic noise and human health in India: review of literature from 1991 to current. *Noise Health* **2012**, 14, 113-118. https://doi.org/10.4103/1463-1741.97255

Banerjee, D.; Chakraborty, S.K. Monthly variation in nighttime noise levels at residential areas of Asansol city (India). *Journal of Environmental Science and Engineering.* **2006**, 48, 39-44.

Basner, M.; Babisch, W.; Davis, A.; Brink, M.; Clark, C.; Janssen, S.; Stansfeld, S. Auditory and non-auditory effects of noise on health. *The Lancet.* **2014**, 383, 1325-1332. https://doi.org/10.1016/S0140-6736(13)61613-X

Basner, M.; Brink, M.; Bristow, A.; de Kluizenaar, Y.; Finegold, L.; Hong, J.; Janssen, S.A.; Klaeboe, R.; Leroux, T.; Liebl, A.; Matsui, T.; Schwela, D.; Sliwinska-Kowalska, M.; Sörqvist, P. ICBEN review of research on the biological effects of noise 2011-2014. *Noise Health.* **2015**, 17, 57-82. https://doi.org/10.4103/1463-1741.153373

Berglund, B.; Lindvall, T. *Community Noise*. Archives of the Center for Sensory Research, 2. Stockholm: Stockholm University, 1995, 2, 1-195. https://www.scirp.org/reference/referencespapers?referenceid=534481

Bhosale, B.J.; Late, A.; Nalawade, P.M.; Chavan, S.P.; Mule, M.B. Studies on assessment of traffic noise level in Aurangabad city, India. *Noise Health* **2010**, 12, 195-198. https://doi.org/10.4103/1463-1741.64971

Chauhan, A.; Pande, K.K. Study of noise level in different zones of Dehradun City, Uttarakhand. *Report and Opinion.* **2010**, 2, 65-68.

Dopico, J.; Schaffer, B.; Brink, M.; Roosli, M.; Vienneau, D.; Tobias, S.; Wunderli, J.M. Annoyance to road traffic noise and residential green: A case study in the city of Zurich, Switzerland. Paper presented at the 14th ICBEN Congress on Noise as a Public Health Problem, Belgrade, Serbia, June 18-22, 2023.

Firdaus, G.; Ahmad, A. Noise pollution and human health: A case study of Municipal Corporation of Delhi. *Indoor and Built Environment.* **2010**, 19. https://doi.org/10.1177/1420326X10370532

Garg, N.; Sinha, A.K.; Dahiya, M.; Gandhi, V.; Bhardwaj, R.M.; Akolkar, A.B. Evaluation and analysis of environmental noise pollution in seven major cities of India. *Archives of Acoustics.* **2017**, 42, 175-788. https://doi.org/10.1515/aoa-2017-0020.

Hunashal, R.B.; Patil, Y.B. Assessment of noise pollution indices in the city of Kolhapur, India. *Procedia-Social and Behavioral Sciences.* **2012**, 37, 448-457. https://doi.org/10.1016/j.sbspro.2012.03.310.

Joshi, A.N.; Joshi, N.C.; Rane, P.P. Noise mapping in Mumbai city, India. *International Journal of Innovative Science, Engineering and Technology.* **2015**, 2, 380-385.

Kuhlmann, J.; Bilik, J.; Liepert, M.; Schutte, S.; Schreckenberg, D. Annoyance due to noise from sports facilities. Paper presented at the 14th ICBEN Congress on Noise as a Public Health Problem, Belgrade, Serbia, June 18-22, 2023.

Kumar, N.; James, A.; Nath, S. Study on noise pollution level in parks of Allahabad City, India. *International Research Journal of Environmental Sciences.* **2013**, 2, 88-90.

Marius, A.; Tijunelis, M.D.; Fitzsullivan, B.A.; Sean, O.; Henderson, M.D. Noise in the ED. The *American Journal of Emergency Medicine.* **2005**, 23, 332-335. https://doi.org/10.1016/j.ajem.2005.02.037

Mirsanjari, M.; Zorufchin, P. The environmental evaluation analysis of traffic noise pollution level in Region 6, Tehran, Iran. *Advances Environmental Biology.* **2012**, 6, 2942-2947.

Oh, M.; Shin, K.; Kim, K.; Shin, J. Influence of noise exposure on cardio cerebrovascular disease in Korea.

Science of The Total Environment. **2019**, 651, 1867-1876. https://doi.org/10.1016/j.scitotenv.2018.10.081

Passchier-Vermeer, W.; Passchier, W.F. Noise exposure and public health. *Environmental Health Perspectives.* **2000**, 108, 123-131. https://doi.org/10.1289/ehp.00108s1123

Pathak, V.; Tripathi, B.D.; Mishra, V.K. Evaluation of traffic noise pollution and attitudes of exposed individuals in the working place. *Atmospheric Environment.* **2008**, 42, 3892-3898. https://doi.org/10.1016/j.atmosenv.2007.12.070

Singh, D.; Prakash, A.; Srivastava, A.K.; Kumar, K.; Jain, V.K. The effects of meteorological parameters in ambient noise modeling studies in Delhi. *Environmental Monitoring and Assessment.* **2013**, 185, 1873-1882. https://doi.org/10.1007/s10661-012-2674-1

Singh, R.; Pandey, G. A study of noise in Gorakhpur city, Uttar Pradesh (India). *International Journal of Structural and Civil Engineering Research.* **2013**, 2, 241-249

Singh, T.V.; Dadoriya, N.S. Intensity of noise pollution in Morena City, Madhya Pradesh, India. *International Research Journal of Environment Sciences.* **2013**, 2, 68-71.

Srivastava, S.; Rai, G. An evaluation of noise pollution level in Lucknow City, Uttar Pradesh. *National Geographical Journal of India.* **2020**, 66, 81-93. https://doi.org/10.48008/ngji.1732

Suksaard, T.; Sukasem, P.; Tabucanon, S.M.; Aoi, I.; Shirai, K.; Tanaka, H. Road traffic noise prediction model in Thailand. *Applied Acoustics.* **1999**, 58, 123-130. https://doi.org/10.1016/S0003-682X(98)00069-3

Thangadurai, N.; Ravichandran, C.; Meena, K. Environmental noise pollution in Salem, Tamil Nadu, India. *Journal of Industrial Pollution Control* **2005**, 21, 347-354.

Tsoi, K.H.; Loo, B.P.Y.; Li, X.; Zhang, K. The co-benefits of electric mobility in reducing traffic noise and chemical air pollution: Insights from a transit-oriented city. *Environment International.* **2023**, 178, 108116. https://doi.org/10.1016/j.envint.2023.108116

Vidyasagar, T.; Rao, N. Noise pollution levels in Visakhapatnam city (India). *Journal of Environmental Science and Engineering.* **2006**, 48, 139-142.

Vijay, R.; Sharma, A.; Chakrabarti, T.; Gupta, R. Assessment of honking impact on traffic noise in urban traffic environment of Nagpur, India. *Journal of Environmental Health Science and Engineering.* **2015**, 13, 1-10. https://doi.org/10.1186/s40201-015-0164-4

Wani, K.A.; Jaiswal, Y.K. Assessment of noise pollution in Gwalior, M.P., India. *Advances in Bioresearch.* **2010**, 1, 54-60.

Yamin, M.; Yousaf, Z.; Bhatti, K.M.; Ibrahim, M.; Akbar, F.N.; Shamshiri, R.; Mahmood, A.; Tauni, R.A. Noise exposure and its impact on the psychological health of agricultural tractor operators. *Noise Control Engineering Journal.* **2021**, 69, 500-506.

Zannin, P.H.T.; Calixto, A.; Diniz, F.B.; Ferreira, J.A.C. A survey of urban noise annoyance in a large Brazilian city: The importance of a subjective analysis in conjunction with an objective analysis. *Environmental Impact Assessment Review.* **2003**, 23, 245-255. https://doi.org/10.1016/S0195-9255(02)00092-6

Zannin, P.H.T.; Diniz, F.B.; Calixto, A.; Barbosa, W. Environmental noise pollution in the city of Curitiba, Brazil. *Applied Acoustics.* **2002**, 63, 351-358. https://doi.org/10.1016/S0003-682X(01)00052-4

Zeid, Q.; She, M.; Abdel-Razia, I.R. Measurement of the noise pollution in the community of Araba. *Acta Acustica united with Acustica.* **2000**, 86, 376-378.

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