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Research Article

Noise Pollution and Its Effects on the Health of Traffic Police along Butwal-Bhairahawa Road, Lumbini Province, Nepal

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Abstract

Traffic noise pollution has emerged as a growing environmental and public health concern in urban areas, particularly affecting personnel with continuous roadside exposure. Traffic police being directly exposed to prolonged roadside noise, possess significant health risks. Despite the risks, limited research has been conducted in this region in assessment of health effect from noise. This study aimed to assess the environmental noise level at eight major traffic junctions along the Butwal Bhairahawa highway in the Rupandehi District and examined associated health impacts on traffic police officers in comparison to local residents. Maximum noise levels ranged from 77.2 to 102.6 dB(A) in the morning (9:00–10:00 AM) and 78.4 to 100.8 dB(A) in the afternoon (1:00–2:00 PM). Yogikuti Chowk recorded the highest morning noise, with an average Leq of 85.32 dB(A). Minimum noise levels ranged from 56.8 to 65.8 dB(A) in the morning and 51.9 to 65.2 dB(A) in the afternoon. Traffic police consistently reported higher rates of health problems across nearly all categories, reflecting their greater exposure to traffic noise compared to local residents. The Chi-square test revealed a statistically significant association between noise exposure and several health problems among traffic police officers specifically, hearing difficulties ($\chi^2 = 7.276$, $p = 0.007$), tinnitus ($\chi^2 = 4.917$, $p = 0.027$) and fatigue ($\chi^2 = 19.728$, $p < 0.001$). In addition, none of the surveyed traffic police officers reported using any form of personal protective equipment (PPE) which highlights a serious gap in occupational safety. This outlines the need of improved traffic management strategies, strict enforcement of noise regulations and increased public awareness to better safeguard the health of both traffic police and public.

1. Introduction

Noise, being continuous element in our modern lives, is more than an everyday disturbance; it characterizes a significant environmental and public health concerns (Sordello et al., 2019; Basner et al., 2014). Commonly unnoticed, it arises from both outdoor as well as indoor sources such as traffic, industrial machinery, household appliances, construction work etc. (Braat-Eggen et al., 2017; Murthy et al., 2007). This rising cacophony affects not only our perception and comfort but also the broader quality of our soundscape (Farooqi et al., 2021), turning it into a global issue with serious need of interventions. Urbanization along with increased motor vehicle use have made noise pollution one of the major environmental stressors in growing cities (Khan et al., 2023). Chronic noise is not merely irritating, it can lead to serious health risks such as hearing loss, cardiovascular diseases, mental health disorders, cognitive impairments, and sleep disturbances (Basner et al., 2014; Babisch, 2014; Münzel et al., 2018). People working in noisy environments, especially in urban settings like offices, factories, or on roads, often experience heightened stress and declining overall well-being (Omivari & Nouri, 2009; Prajapati et al., 2023).

Traffic-related noise, in particular, has emerged as a major contributor, with research linking it to elevated blood pressure, anxiety, poor memory, and reduced learning performance (Stansfeld & Matheson, 2014; Evans & Maxwell, 2007). With the constant roadside exposure in high-traffic zones, traffic police are among the most vulnerable group having harmful effects of

excessive noise (Das et al., 2023). In addition to high levels of noise, vehicular emissions, dust, and extreme weather for long hours daily, induce both physical and mental health challenges (Shrestha et al., 2023). Accounting the growing urbanization and elevate daily noise level, studies (Tahir & Bahzad, 2015; Starčević, & Bojović, 2016) have addressed noise pollution's impact on traffic personnel in different cities. However, a noticeable gap is observed in research with specific focus on occupational risks faced by traffic police along busy urban hubs in Nepal.

This study aims to address the gap by providing comprehensive assessment of intensity of noise pollution along the Butwal-Bhairahawa road with an underexplored impact on the health of traffic police personnel stationed there. It seeks to quantify noise exposure levels, identify the health symptoms most commonly reported by affected officers, and analyze the relationship between noise exposure duration and the severity of health outcomes. Ultimately, the study intends to inform policy and propose practical recommendations for safeguarding the well-being of this often-overlooked group of frontline urban workers.

2. Materials and Methods

2.1 Study Area

The Butwal-Bhairahawa route, a major transportation corridor in Lumbini Province of Nepal, spans approximately 27 kilometers and connects the industrial along with commercial centres of Butwal with the adjoining city of Bhairahawa along the East-West Highway. It also includes part of the strategic Asian Highway (AH42). The corridor is surrounded by urban settlements, marketplaces, institutions, and hospitals, all of which are potentially sensitive to elevated levels of environmental noise. A daily, high volume of vehicular traffic, including buses, trucks, motorcycles, and private vehicles, making it one of the busiest road sections in the region. The diverse sources of noise; ranging from honking, engine vibrations, and road construction to human activities subject for the assessment of environmental sound levels and their health impacts.

This route passes through four different local units gradually developing as urban residential setting. Two major traffic junctions from each local bodies; altogether eight junction in total were selected for study which experiences highest traffic number along the route (Table 1).

Table 1: Sampling location in four different local unit along Butwal-Bhairahawa route.

Local Unit	Locality	Co-ordinates	Remarks
Butwal Sub-Metropolitan City	Hospital Line	27°41'49.31"N, 83°28'0.14"E	Nepal's fastest growing cities Major economic hub
	Chauraha	27°41'8.91"N, 83°27'53.89"	Located at the intersection of two key highways Butwal-Bhairahawa and East-West highway
Tilottama Municipality	Yogikuti Chowk	27°40'4.96"N, 83°27'53.19"E	Residential area
	Manigram	27°37'44.94"N, 83°28'23.39"E	Butwal-Tilottama-Bhairahawa junction
Omsatiya Rural Municipality	Katiya	27°33'3.30"N, 83°27'46.30"E	Residential area
	Lakhan Chowk	7°31'40.19"N, 83°27'23.48"E	Industrial area
Siddharthanagar Municipality	Devkota Chowk	27°30'21.70"N, 83°27'22.49"E	administrative headquarters of Rupandehi District Near to Gautam Buddha International Airport.
	Belahiya	27°28'38.98"N, 83°28'10.90"E	Proximity to the Indian border

2.2 Methods

This study employed a descriptive cross-sectional design to explore the relationship between noise pollution and the health of traffic police officers stationed along the Butwal–Bhairahawa roadway across 28.2 km of diverse urban and semi-urban settings. A non-probability convenience sampling method was employed for its practicality and ease of access, allowing researchers to reach participants who were both readily available and significantly exposed to traffic noise. Data were collected over eight consecutive days (January 15–22, 2023) at eight major traffic junctions.

Noise levels were measured using Sound Level Meter (SLV- TM-103) configured to "Fast" response mode with dB (A) weighting. The sound level meter was placed at a height of 1.5 meters above ground level, for simulating human ear height during standing posture

(ISO 1996-2:2017). Measurements were recorded every minute in order to capturing short-term fluctuations in traffic flow, ensuring a more accurate representation of real exposure during three specific time intervals; 9:00-10:00 AM, 11:00-12:00 AM, and 1:00-2:00 PM to represent both the peak and moderate traffic conditions. The first interval coincides with morning peak traffic as people travel to work and schools, while the late-morning and early-afternoon sessions capture periods of continued but varying traffic intensity.

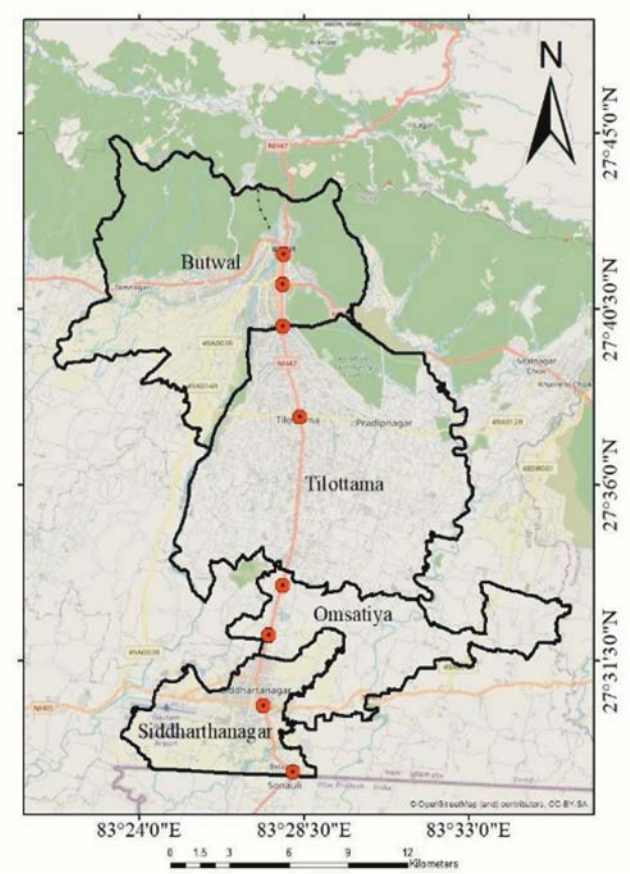

Figure 1: Butwal-Bhairahawa roadway showing study points in four different local units.

Perception-based data of 89 respondents were collected alongside sound measurements using structured questionnaires. Since traffic police are disproportionately affected by noise pollution due to their constant roadside exposure, all 56 on-duty traffic officers available during the sampling period were interviewed and a smaller number of local residents (33 persons) were included primarily for comparison, as their exposure is intermittent and less intense than that of traffic personnel. During the interview, confidentiality and anonymity were maintained to encourage honest responses and ensured that the respondents are from the same location of sampling sites.

The survey gathered demographic details and self-reported health effects linked to noise exposure; such as sleep disturbances, stress, fatigue, and hearing issues as well as any protective measures used. Comparing responses between the two groups provided insight into differences in occupational and community-level vulnerability to noise pollution.

2.3 Data Analysis

The collected data were analyzed in Microsoft Excel to examine the relationship between noise exposure and reported health impacts. A Chi-square test was done to assess the relation between different variables. Local residents were used as a reference group to contextualize the specific risks faced by traffic police officers. Additionally, the equivalent sound pressure level (LAeq.T) was calculated to determine the average noise exposure using following formula cited from Banerjee et al., 2009:

$$\text{LAeq.T} = 10\log_{10}\left(\frac{1}{n}\sum_{i=1}^{n}10^{\frac{Li}{10}}\right)\text{dB(A)}$$

Where:
LAeq.T = equivalent continuous A-weighted sound level over the measurement period T
n = total number of discrete measurements (1-minute readings)
Li = individual A-weighted sound level measurement at each interval i

3. Results

3.1 Respondent Characteristics

The demographic profile of the respondents showed that among traffic police officers, 82% were male and 18% female, with a mean age of 31.95 years; most (64%) were aged 30-40 years. Among local residents, 58% were male and 42% female, with a mean age of 32.67 years; the largest age group (43%) was 20–30 years old.

3.2 Noise Levels at different locations

Noise levels were measured at eight traffic junctions, showing significant fluctuations (Figure 2). Maximum noise levels ranged from 77.2 to 102.6 dB(A) in the morning (9:00–10:00 AM) and 78.4 to 100.8 dB(A) in the afternoon (1:00–2:00 PM). Yogikuti Chowk recorded the highest morning noise, with an average Leq of 85.32 dB(A), attributed to rush hour traffic and nearby schools and businesses. In the afternoon, Belahiya Chowk showed the highest levels, with an Leq of 84.52 dB(A), likely due to increased heavy vehicle movement near the Indo Nepal border.

Minimum noise levels ranged from 56.8 to 65.8 dB(A) in the morning and 51.9 to 65.2 dB(A) in the afternoon. Katiya Chowk recorded the lowest morning levels, while Belahiya Chowk had the overall minimum of 51.9 dB(A) in the afternoon, likely during a period of reduced traffic numbers.

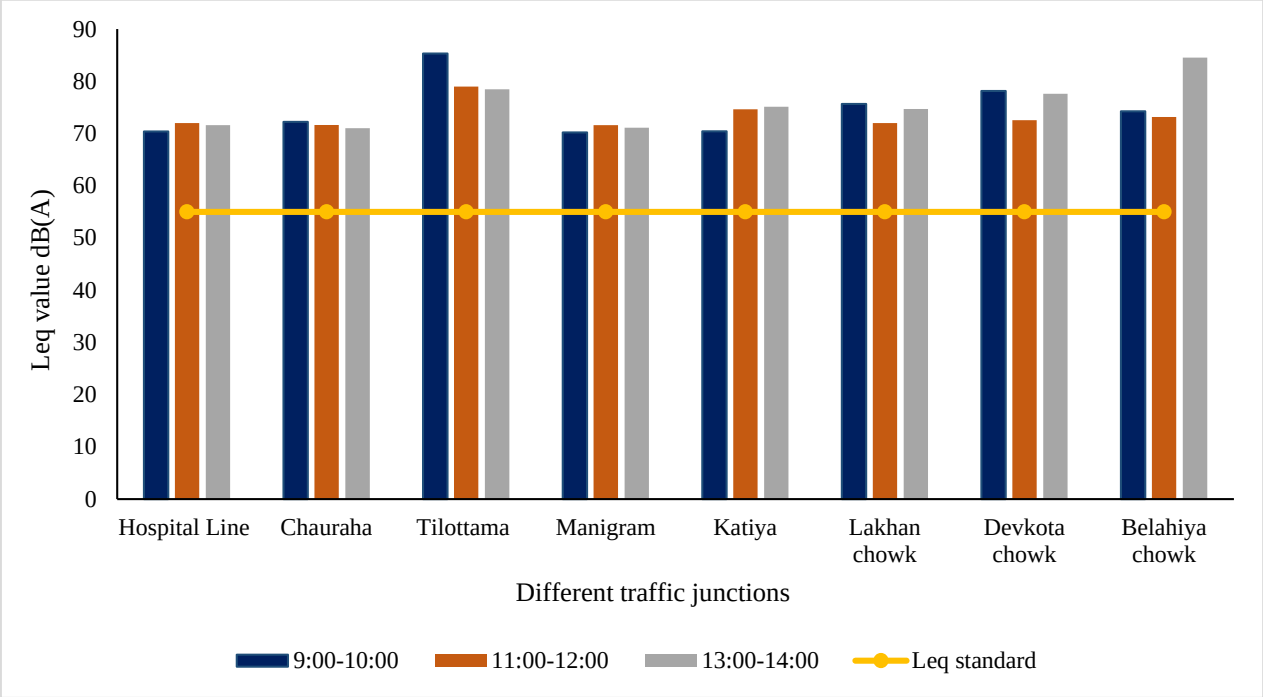

Figure 2: Noise Level at eight studied locations with a reference line of 55 dB(A) as a standard value for urban residential area set by the *National Ambient Sound Quality Standard, 2012* (MoFE, 2012)

3.3 Noise Impact on Health

The study found varying health impacts among traffic police and local residents, with traffic police generally experiencing more pronounced effects (Figure 3).

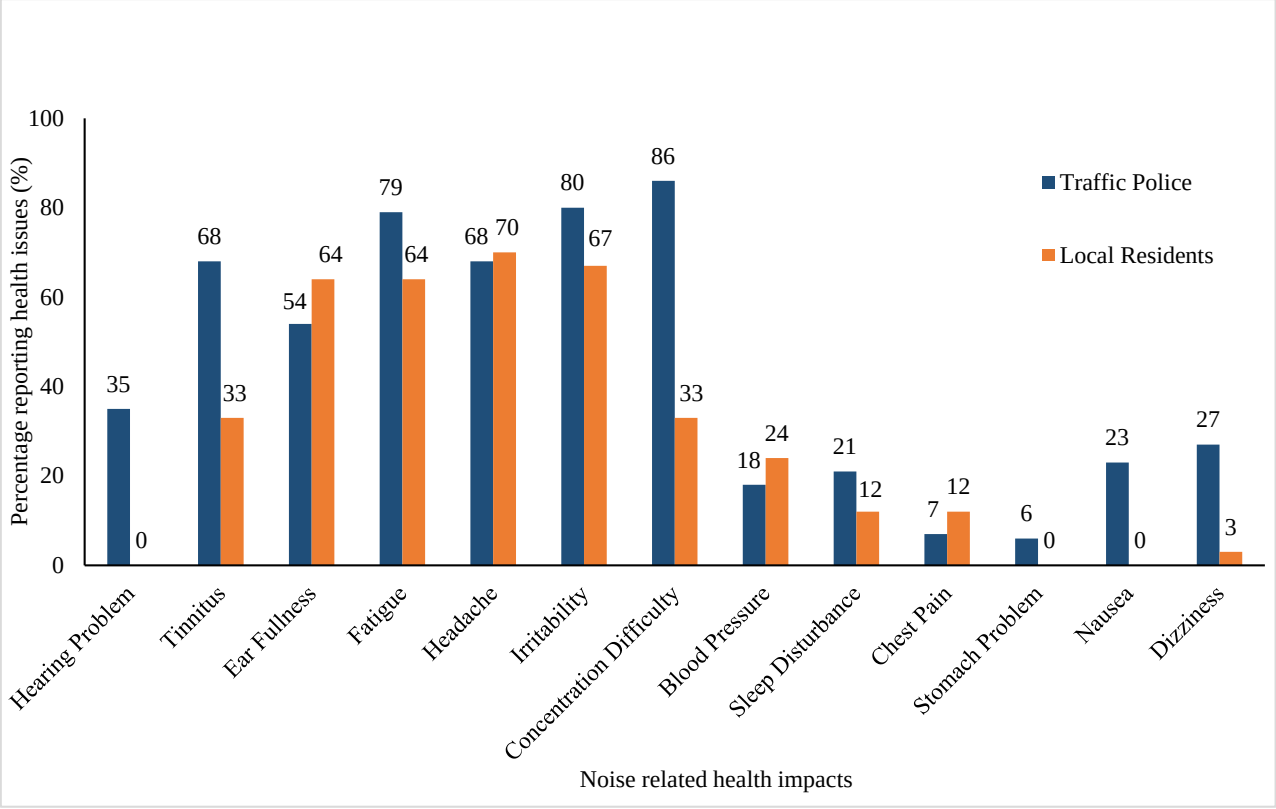

Figure 3: Comparison of noise impacts on health of respondents

Traffic police consistently reported higher rates of health problems across nearly all categories, reflecting their greater exposure to traffic noise. Notably, conditions such as concentration difficulty (86%), irritability (80%), fatigue (79%), and tinnitus (68%) were significantly more prevalent among traffic police compared to local residents. In contrast, local residents reported relatively lower rates of all symptoms, with several conditions such as hearing problems, nausea, and dizziness. These findings highlight the greater occupational vulnerability of traffic police to noise-induced health effects.

The Chi-square test revealed a statistically significant association between noise exposure and several health problems among traffic police officers. Specifically, hearing difficulties ($\chi^2 = 7.276$, $p = 0.007$), tinnitus ($\chi^2 = 4.917$, $p = 0.027$), fatigue ($\chi^2 = 19.728$, $p < 0.001$), irritability ($\chi^2 = 7.309$, $p = 0.007$), difficulty concentrating ($\chi^2 = 27.285$, $p < 0.001$), nausea ($\chi^2 = 4.725$, $p = 0.030$), and dizziness ($\chi^2 = 4.144$, $p = 0.042$) were all significantly more prevalent among traffic police compared to local residents. In contrast, symptoms such as ear fullness, headache, blood pressure variations, sleep disturbances, chest pain, stomach issues, and emotional instability showed no statistically significant difference between the two groups (all $p > 0.05$), suggesting that these may be influenced by factors other than noise exposure alone.

3.4 Mitigation Measures

Despite awareness initiatives, campaigns and regulatory efforts, the study reveals a lack of effective and practical noise mitigation strategies. In the absence of systematic mechanism, traffic police personnel themselves have adopted improvised coping mechanisms, such as alternating their shifts or rotating duties in noisy areas to reduce exposure duration. However, these measures are temporary and not sufficient in addressing the adverse impacts of noise-related physical and mental stresses. In addition, none of the surveyed traffic police officers reported to have using any form of personal protective equipment (PPE), such as earplugs or earmuffs, which are basic measures for noise protection. This specifies the gap in use of protective equipments against the adverse impacts from prolonged exposure to noise.

Discussion

Comparing L_{eq} (Equivalent Continuous Sound Level) values recorded at eight traffic junctions during three different time periods against the *National Ambient Sound Quality Standard* for urban residential areas (55 dB(A); MoFE, 2012) indicates that, noise levels at all selected sites substantially exceed the permissible limit across all time intervals. This indicates that the traffic police officers along the Siddhartha Highway in Rupandehi District are subjected to consistently elevated levels of noise pollution, indicating more noise than that set for the regions with industries i.e. 75 dB(A) (MoFE, 2012). The exceeding level of noise is not only witnessed along Butwal–Bhairahawa highway but also around different cities in Nepal. For example, Puri et al. (2025) reported peak-hour noise in Kathmandu Valley traffic zones reaching 97.3 dB(A), while Adhikari et al. (2025) recorded levels up to 76 dB(A) in Dhading Besi.

The higher level of noise during the morning period of 9:00–10:00 AM are often attributed to high vehicular density, inadequate traffic management, and the frequent use of pressure horns by drivers. The findings are in line with other studies from noisy urban regions such as reported by Kisku et al. (2006). Even Hospital Line, which ideally should have lower noise levels of 50 dB(A) (MoFE, 2012), exceeded the standard, raising serious public health concerns. Transportation, being major source of noise, is primarily responsible for these elevated levels. Similar patterns have been observed in Kathmandu Valley, where Singh et al. (2022) and Chauhan et al. (2021) recorded noise levels above 65 dB(A) in high-traffic areas. Multiple studies across Nepal have revealed consistent violations of national noise standards. For instance, Sharma et al. (2021) reported levels exceeding 90 dB(A) during daytime in Bharatpur. Likewise, Belahiya Chowk exhibited a noticeable increase in sound levels during 1:00–2:00 PM, likely due to commercial activities and carriage transportation associated with mid-day Indo-Nepal trade in border areas.

The excessive noise levels are known to have detrimental effects on both physical and mental health (Basner et al., 2014; WHO, 2018). Traffic police are at the higher risk of noise-related health impacts compared to local residents, as they experience extended and direct exposure to elevated sound levels at traffic junctions. In Kathmandu, more than 50% of traffic police were found to have hearing loss (Bista & Dahal, 2016; Shrestha et al., 2011). Shrestha et al. (2023) also noted that 61.4% of Kathmandu traffic police were identified with hearing impairment as a major consequence linked to noise exposure. Apart from auditory effects, they were also reported to have major impacts on mental health with fatigue, irritability, and difficulty concentrating than local residents, which are known as non-auditory impacts of prolonged noise exposure (WHO, 2018; Basner et al., 2014). The increasing frequency of auditory and non-auditory complaints among traffic officers aligns with findings from Singh and Davar (2004), who reported similar effects in Indian urban settings. Studies conducted in industrial and transport hubs, Pepsicola, Kathmandu documented evening noise levels averaging 97.3 dB(A), which were linked to sleep disturbance, stress, and hearing discomfort (Paudel et al., 2025). These findings align with the present study, where significant associations with nausea and dizziness were observed, supporting WHO's recognition of environmental noise as a major health risk (WHO, 2018; Clark & Paunovic, 2018).

In contrast to the observation in traffic police, local residents likely being safeguarded by structural barriers and distance from traffic flow were reported with fewer such complaints. Goines and Hagler (2007) reported that local residents experienced fewer symptoms possibly due to their intermittent exposure to traffic noise, greater distance from the road, or protective elements such as buildings and vegetation. While local residents did report some symptoms, they were significantly fewer and less severe. This results aligns with Puri et al. (2025), who found that the proximity and duration of exposure were major factors determining the health impacts between traffic officers and general public.

The constantly high sound levels recorded across multiple locations is linked with the rising occurrence of health impacts among traffic officers, indicating a strong concern toward occupational health risk. The lack of protective measures emphasizes a significant negligence in occupational safety protocols and reveals a critical gap in the institutional framework in safeguarding health and well-being of traffic personnel regularly exposed to hazardous noise levels. The complete absence of personal protective equipment (PPE) among traffic officers is concerning. None of the surveyed officers used earplugs or earmuffs, illustrating similar findings as by Ismaila and Odusote (2014), who documented low PPE adoption among workers in Nigeria exposed to occupational noise. Similar lacking were documented by Shrestha et al. (2023) where persons were not using protective devices even in environments where noise-induced stress was widely witnessed. This outlines a global issue of inadequate protection in noise exposed jobs.

4. Conclusion

The study confirms that traffic noise levels at all surveyed junctions along the Butwal-Bhairahawa Highway far exceed Nepal's urban residential standard of 55 dB(A) with Leq values ranging from 70.2 to 85.3 dB(A). The elevated noise levels pose serious occupational hazards for traffic police, who are regularly exposed without adequate protection. Local residents in comparison to traffic officers reported significantly lower rates of both auditory (e.g., tinnitus, hearing loss) and non-auditory (e.g., fatigue, irritability, concentration issues) health symptoms. In addition, the complete absence of personal protective equipment among traffic officers highlights a critical gap in occupational safety.

Analyzing the elevated noise level and health impacts on traffic officers, it is recommended to implement necessary intervention to protect the well-being of traffic personnel and mitigate the broader public health impacts of urban traffic noise. Authorities should implement PPE programs, ensuring regular supply and mandatory use of earplugs or earmuffs along with regular health screenings focusing on auditory and mental health in traffic services. Promotion of noise barriers, quieter transport alternatives, and "no horn zones" can improve the noise level. In addition to this, the study recommends revision of traffic management strategies, strict enforcement of noise regulations and increased public awareness to better safeguard the health of both traffic police and public.

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CRediT Author Statement

PB: Conceptualization, Methodology, Investigation, Analysis, Writing- original draft, Writing- Reviewing and Editing; **USS:** Conceptualization, Methodology, Supervision, Writing-Reviewing and Editing; **TR:** Writing - original draft, Analysis, Writing-Reviewing and Editing

Conflict of Interest

There is no conflict of interest in the publication of this article.

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