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Exposure of Road Users to the Traffic Noise in Urban Environment – Insights from a Mega Metropolitan City

Running Title: Exposure of Road Users to the Traffic Noise in Urban Environment

ABSTRACT

An increase in urban traffic especially in developing countries like Pakistan has led to huge noise chaos on the major arterials with a lack of facilities to manage it. Such harmful excessive noise from road traffic creates a direct impact on the daily commuters and can have severe health consequences such as hearing loss, stress, and heart disease. Despite the alarming situation discussed above, research on the aforementioned topic in the developing world is limited. This paper for the first time measures the traffic noise experienced by four road user groups which include: 1) Car drivers with open windows, 2) Car drivers with closed windows, 3) Motorbike riders with helmets and 4) Motorbike riders without helmets. The noise level experienced by these four road user groups was measured by travelling on one of the major routes (i.e., Saddar to 4K Chowrangi via Rashid Minhas Road) in Karachi (Pakistan) with four different devices. The highest noise level was 110 dBA obtained from non-helmeted bike riders while the closed window car users received the least level of 49.8 dBA. Furthermore, there was no significant difference observed in the noise for helmet and non-helmet users. Therefore, there is a need to improve the design of helmets for reducing noise impact. The Analysis of variance test performed also shows that the noise experienced by the motorcyclist is significantly higher than that of commuters in cars.

Keywords: Heterogeneous Traffic; Motorbikes; Karachi, Pakistan; Noise Chaos; Helmet

1. INTRODUCTION

Noise generated from transportation networks is a major contributor to the noise experienced by inhabitants of an urban area (Wang et al., 2005). In modern urban communities, vehicular noise accounts for 80% of all noise sources and has become a widespread issue with the constant increase in traffic (Lezhneva et al., 2019, Grubesa and Suhanek, 2020). Globally the continuous growth of noise within cities of developing countries is primarily experienced alongside roads with dense traffic where the equivalent sound pressure is high i.e. 75-80 dBA. It is considered unsustainable because of its direct impact on human health (Berglund et al., 1999). According to the World Health Organization (WHO), traffic noise leads to a loss of at least one million healthy life years per year only in Western Europe (Organization, 2011). The WHO uses Community Noise Equivalent Level (CNEL) to address the road traffic noise levels associated with above 53 decibels (dBA) as negative to human health (Batterman et al., 2021). The impacts of traffic noise are not limited to humans but also impact the natural environment by creating deleterious effects on animals. The way of communication and migration pattern of many birds and other animal species has been widely disturbed due to higher noise levels within the urban environment (Parris and Schneider, 2009).

Transportation noise has not only a significant impact on the urban environment, but it also affects roadway users including pedestrians, bicyclists, motorcyclists, drivers, and passengers. In the case of drivers and motorbike riders, the impact of noise could be life-threatening because it affects drivers' performance (Anund et al., 2015). Travel activities can cause a significant increase in stress levels of daily commuters not only in developing but also in developed countries (Jahangeer et al., 2021). Noise can affect individuals variably based on some factors including its intensity, duration of exposure, gender, and age of the person (Beheshti et al., 2019). The noise levels exceeding safer levels i.e., above 85 dBA for 8-hour exposure, are considered potentially hazardous to human health (Neitzel and Fligor, 2019). Studies show that excessive noise can deteriorate health in various forms including sleep disorders, cardiovascular disease, hypertension, etc. (Stansfeld et al., 2000). A study conducted in Tabriz city of Iran concluded that exposure to higher noise levels impacts on performance and health of inhabitants, which increases with the age (Ahmadi and Dianat, 2019). Kou et al. (2020) collected data on momentary noise, perceived noise, and psychological stress of selected individuals in Beijing, China, and concluded that momentary noise exposure adversely affects psychological stress through mediating effect of momentary perceived noise. In another study, the authors used geographic ecological momentary assessment (GEMA) and portable noise sensors to conclude that noise annoyance mediates the association between psychological stress and noise exposure in real-time (Tao et al., 2020).

A noise level greater than 55 dBA is considered sensitive and it has a potential hazard if it exceeds 80 dBA (Moroe and Mabaso, 2022). Guangzhou, China is reported as the city with the highest noise levels worldwide followed by Delhi (Gray, 2017, Keegan, 2018). A study conducted in Delhi, India shows that the traffic volume and type of vehicle depict the variation in noise levels. The equivalent noise levels (Leq) observed in the city range between 53 dBA and 83 dBA, which is far greater than the prescribed limits(Dass et al., 2017, Akhtar et al., 2012). Beijing, China is ranked among the top ten worst cities in terms of noise levels (Gray, 2017, Keegan, 2018). In 2016 noise data from 322 cities in China shows that noise generated from urban traffic has an A-weighted sound pressure level (Leq) of 66.8 dBA which is accountable for 21.7% of noise sources (Wu et al., 2019). Considering the aforementioned facts and the alarming situation, reducing road traffic noise has been on the political agenda of various countries worldwide. Different countries have set limits, guidelines, and recommendations to reduce road traffic noise. China regulations set 70 dBA and 55 dBA ambient noise exposure limits along the roadside during day and night, respectively (Lin-hua et al., 2013). Europe recommends that average road noise exposure must be reduced to 53 dBA and lowered up to 45 dBA during the nighttime to reduce potential adverse effects on human health (Organization, 2018). The United States Environmental Protection

Agency (US EPA) considers the average noise exposure limit to be 55 dBA for 24 hours to decrease any harmful effects on health (Hammer et al., 2014).

The noise generated during travelling also depends on the characteristics of the vehicle. For instance, Flor et al. (2020)found that the cabin noise inside a car is a combination of different noises having diverse natures, including wind noise, engine noise, and rolling noise. These noises must be considered carefully while dealing with the acoustics of a vehicle system along with working out mathematical models to describe them. Hence, such assessments are essential for vehicle interior noise analysis. Different studies on traffic noise estimation suggest the impact of several factors on traffic noise generation, such as the effect of traffic volume, composition of traffic, traffic speed, horn, number of lanes, the width of lanes, approach width, road slope, and pavement surface texture(Muralikrishna et al., 2017, Grubesa and Suhanek, 2020).

Several studies have been conducted in both developing and developed countries to assess the impact of noise generated by traffic. These methods focus on creating noise prediction models factoring in various variables that account for noise emissions. However, the main focus of these studies remains the impact of traffic noise on the outdoor environment surrounding the roadway network. The different methods that have been adopted either map the noise in the surroundings or estimate the future noise levels based on the existing or slightly modified noise prediction models. The results are then compared with the environmental standards established by the regulatory bodies to validate safer noise levels and mitigation measures are hence proposed to overcome exceeding levels of noise traffic (Haron et al., 2015, Tandel and Macwan, 2017).
There is significant heterogeneity in the traffic composition and driving behaviour in developing countries in comparison with developed countries. Hustim and Fujimoto (2012) suggested that for carrying out noise-related studies, the distinction between the heterogeneity of traffic in developing countries and the homogeneity in developed countries must be considered. Motorbikes make up a large proportion of the modal share in the traffic stream in developing countries. Phan et al. (2010) compared the traffic noise in Hanoi and Ho Chi Minh City, Vietnam with that in Japan. The difference in the datasets was largely attributed to motorbike ownership i.e., they form up about 96% of all local transportation as per the statistics of the World Bank; along with the frequent use of horns. Furthermore, the frequent use of horns in developing countries compared to that in the developed world is detrimental to the measurement of overall noise exposure levels. Alves Filho et al. (2004) found that the behaviour of Brazilian drivers i.e., excessive use of horns, without any genuine reason along with accelerating in traffic jams causes variations in the noise readings. Alam et al. (2020) conducted a comprehensive review of different noise-related studies particularly noise monitoring for developing countries. About 22 countries and 25 cities of the developing world were scrutinized, predominantly based on the pedestrian and the outside environment as the receiver of traffic noise. Mishra et al. (2010) measured the noise along bus corridors in Dehli and suggested measures to reduce the impact of noise. Monazzam et al. (2015) studied the impact of the school reopening on noise in Tehran and reported that there was no significant change in urban noise due to the school reopening. Kou et al. (2020) collected data on momentary noise, perceived noise, and psychological stress of selected individuals in Beijing, China, and concluded that momentary noise exposure adversely affects psychological stress through mediating effect of momentary perceived noise. In another study, the authors used geographic ecological momentary assessment (GEMA) and portable noise sensors to conclude that noise annoyance mediates the association between psychological stress and noise exposure in real-time (Tao et al., 2020).

In many developing countries, the motorbike is the most common mode of transport. Motorbikes are about 75% of total registered vehicles in Pakistan (Abbas, 2022). A study conducted in major cities of Pakistan concluded that about 60% of motorbike riders do not use a helmet, and the helmet being used are mostly substandard (Abbas, 2022). The motorbike riders experience a higher level of noise due to being completely exposed to the road environment. Similarly, the cars on the roads consist of more than 30 years old vehicles (Khan and Ahmad, 2012). In absence of a proper motor vehicle inspection process, the older vehicles operate without temperature control devices such as air conditioners and heaters (Sánchez-Triana et al., 2014, Ansari, 2015). In hot weather, most drivers of cars without air conditioners have to drive their cars with open windows as it becomes extremely hot within the car in high temperatures. One of the drawbacks of driving with open windows is exposure to traffic noise. Thus, motorbike riders and drivers of cars with open windows are more exposed to the road environment than the drivers and passengers of standard cars.

2. RESEARCH GAPS AND CONTRIBUTION

The review of existing literature on traffic-related noise shows that:

- Most of the existing research focused on measuring and modelling the impact of road traffic noise on the environment and inhabitants residing near the roadway network. However, research on the road traffic noise experienced by road users is limited.
- While few studies look at how road traffic noise relates to roadway users, they have focused on car drivers in standard conditions (closed windows). The existing literature lacks the evaluation of noise experienced by car users with open windows and its comparison with standard car users with closed windows.
- In some countries (e.g., developing countries like Pakistan), motorbikes make up a major portion of the urban traffic stream due to which the impacts of noise on the riders with and without helmets become important; however, there is no exclusive study which has looked at the impacts of road traffic noise on bike-riders.

This research for the first time measures traffic noise experienced by roadway users which include1) Drivers travelling in cars with an open window, 2) Drivers travelling in cars with a closed window, 3) Motorbike riders with helmets, and 4) Motorbike riders without a helmet. The noise measured for these four road user groups is compared to determine the exposure of these road users to road traffic noise so that their vulnerability to noise impacts could be evaluated. The findings are expected to provide firm knowledge and foundation to the automotive and motorcycle (as well as helmet-related) industries which they might consider helpful when designing the windows of cars and helmets to be used in developing countries like Pakistan.

The rest of the paper is organized into the methodology, results and discussion, limitations and future direction, and conclusions sections. The methodology section presents the details about the study area, route, modes, and equipment used in this research. The results from the analysis of data are discussed in the results and discussions section. The limitations of the present study along with possible extensions are discussed in the limitations and future direction section. Finally, the conclusions of the study are given in the conclusions section.

3. METHODOLOGY

3.1 Study Area

The noise experienced by the four road user groups is measured along a selected major route (for details, please see Figure 1 or the subsequent paragraph) in Karachi. Karachi, the economic hub of Pakistan with more than 20 million population, is experiencing rapid growth in private vehicles (Bank, 2018, Khan et al., 2022). Due to the lack of public transport system, the usage of motorcycle and cars have increased significantly during the past decade (Noman et al., 2020). Around 50% of vehicles are motorbikes and more than 30% of cars are included in the traffic composition in Karachi (Ahmed et al., 2019). Thus, motorbikes and cars are the two main modes of transport in Karachi. Furthermore, this heterogeneous traffic does not follow lane discipline which creates a chaotic traffic system.

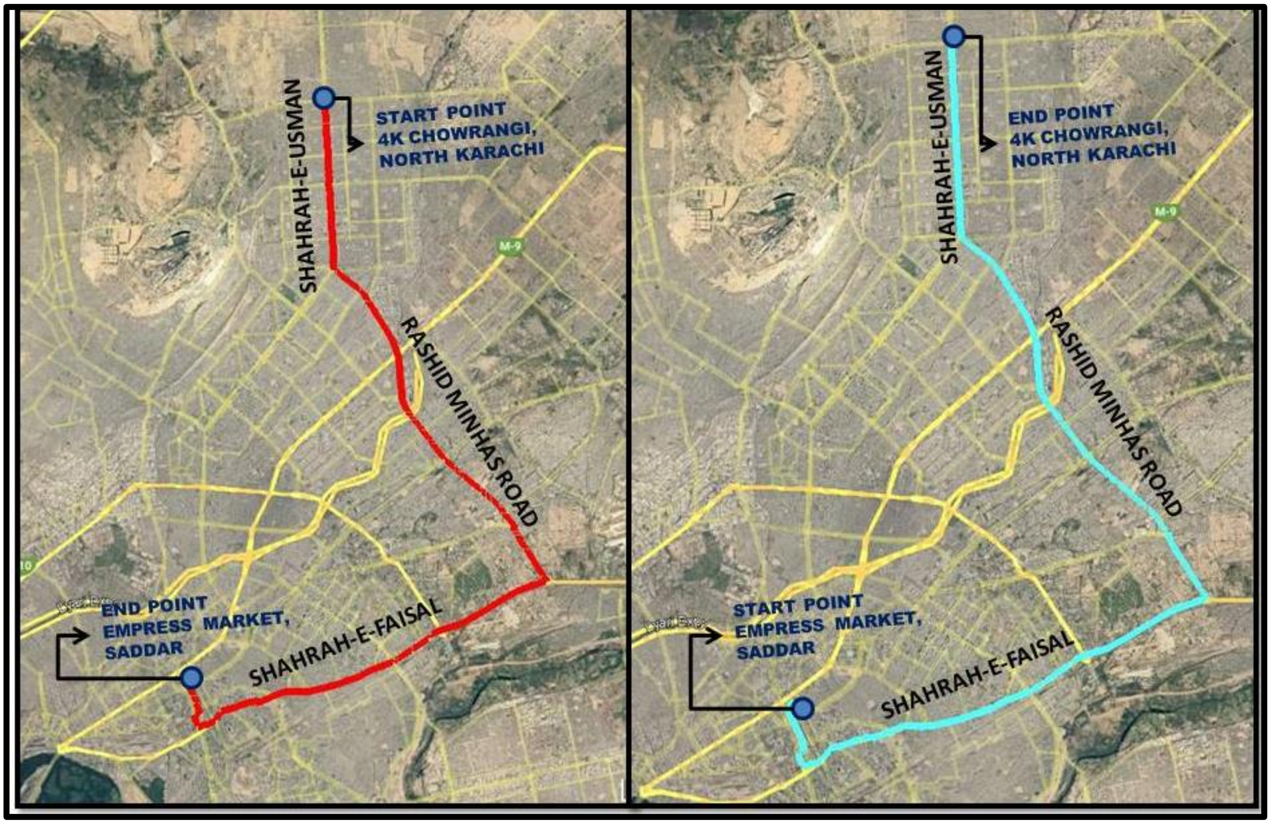

Figure 1 Study route for noise data collection (Left: Towards CBD, Right: From CBD)

The route selected for this study is one of the busiest routes in Karachi, which consist of six major arterials in Karachi. The selected route consists of Shahrah-e-Usman, Rashid Minhas Road, Shahrah-e-Faisal, Club Road, Abdullah Haroon Road, Preddy Street, and Depot Lines as shown in Figure 1. Shahrah-e-Faisal originates from Jinnah International Airport and ends at Metropole Hotel in the city centre. The 18-km long stretch passes through Faisal Cantonment, Gulshan-e-Iqbal Town, Jamshed Town, and Karachi Cantonment connecting the areas with the Saddar Town, the Central Business District (CBD) of the city. Rashid Minhas Road and Shahrah-e-Usman pass through the most populous towns of Karachi. Club Road, Abdullah Haroon Road, Preddy Street, and Depot Lines are internal roads within CBD and are mostly found in a congested state.

3.2 Study Details

The data collection was performed on Wednesday, July 20th, 2022 and the data was collected at two different timings on the selected route. The data collection journey towards CBD started from 4K Chowrangi on Shahrah-e-Usman and was completed at Empress Market in the CBD during 3-4 PM. The one-way journey was approximately 25 km which took around 50 minutes. The return journey on the same route commenced from Empress Market in CBD at 5:50 PM and was completed at 7:05 PM.

3.3 Measurement Setup

To measure the noise experienced by the selected four road user groups, a fleet of test vehicles consisting of two cars and one motorbike was formed, which was driven in the centre lane of the selected route. The platoon of test vehicles was driving together, following the same route and the noise was recorded at the same time. The timings of the noise meters were synchronized to obtain the readings for comparative analysis. Four noise meters of the identical model were used to record the noise level experienced by the motorbike rider with a helmet, without a helmet and the car driver with open and closed windows. The fleet of vehicles was driven at the average speed of the traffic stream as floating cars in traffic. Both the cars were identical sedan cars with 1600cc internal combustion engines and manufactured in 2018. One of the cars was driven with closed windows and with AC. Whereas, the other car was driven with all windows open and AC was not turned on. The motorbike riders recording the noise experienced by motorbike riders riding with and without a helmet were riding on the same motorbike. The rider was wearing a helmet, whereas the pillion rider was not wearing the helmet, and both were recording noise at ear level using two separate sound meters. The sound meters in cars were also placed at the ear level of the drivers as shown in Figure 2.

The sound meter selected for this study, UNI-T UT353 BT, can automatically record the sound and generate a log of sound readings, which can be extracted as an output file. The selected sound meter meets the specifications of IEC61672 Type 2 and ANSI S1.4 Type 2 Sound Level Meter, which can measure A-weighted noise from 30 dBA to 130 dBA with an accuracy of ±1.5 dBA at a resolution of 0.1 dBA. The sound meter can be connected to a mobile device using Bluetooth to record the observations, which can be exported in a data file. The sound meter used in this study has a sampling rate of 125 ms and the mobile application connected with the sensor records average noise level Leq at an interval of 0.5 seconds. Thus, the recorded observations represent all road noises including noise produced by horns. The sound intensity was recorded at a higher resolution with a frequency of two readings per second. The log of sound intensity readings is exported in a CSV file. A dashboard GPS-enabled camera (Road Eye Camera) was also used to record the video of the traffic stream. The sound meters were placed at the ear level to record the traffic noise falling on the ears.

Figure 2 Experimental setup showing cars and motorbikes equipped with sound meters

3.4 Data Extraction

Separate data logs were created for all four road users selected for this experiment. The sound pressure level was recorded after every 0.5 seconds for all the modes separately for the entire travel time over the stretch at both sides (origin to destination and viz a viz) of selected urban arterials. The variation in sound level for the modes under observation was found by plotting the noise level against the time interval. The values were then compared with the sensitivity level (Moroe and Mabaso, 2022).

4. RESULT AND DISCUSSION

The distribution of noise levels observed for all four modes for both journeys is shown in Figure 3. The values of noise levels were averaged for every second. Figure 3 shows a clear difference in the noise observed for all four road users. As expected, the least values of intensity level were observed for the car with closed windows, whereas the highest values were observed for the motorbike without helmets. The distribution of sound intensity levels shown in Figure 3 indicates that the mode value of the car with closed windows is 65 dBA, whereas the mode value of the car with open windows is around 75 dBA during peak hours. The mode of intensity level for motorbike riders with and without a helmet is around 85dBA. This shows that there is a significant difference in the noise levels observed for the car with closed windows, the car with open windows, and motorbike riders. However, the difference in noise levels for motorbike riders with and without a helmet is almost negligible.

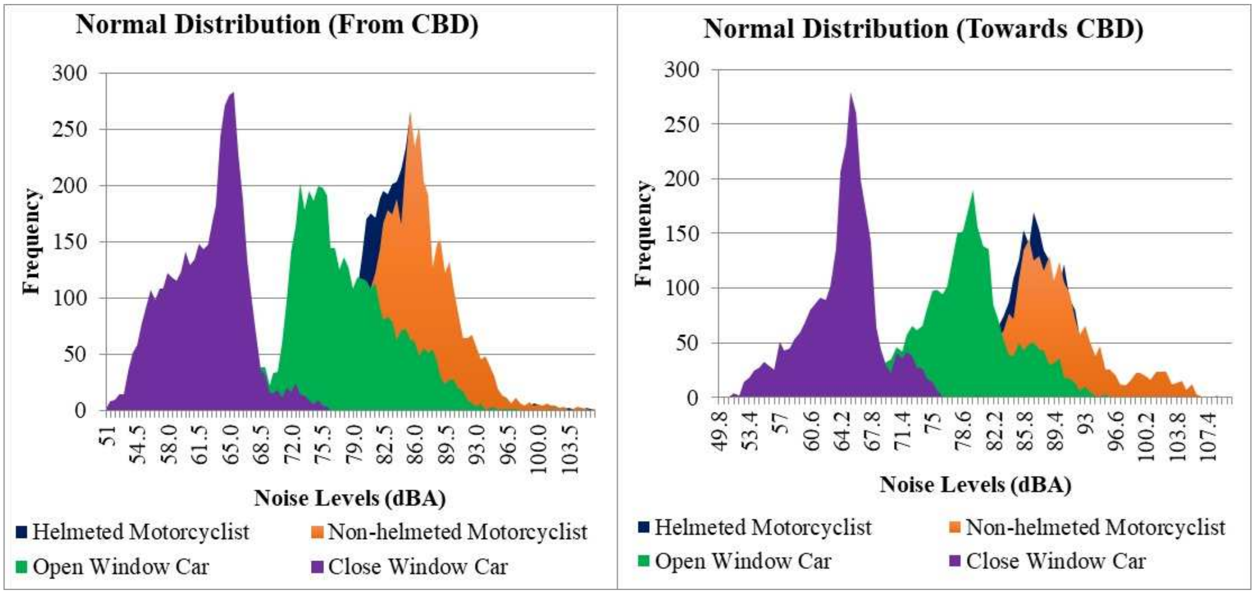

Figure 3 Distribution of observed noise for selected road users

The composition of traffic noise levels in the combined data observed for different roadway users is shown in Figure 4. Overall, a significant amount of data contains noise levels between 75 to 95 dBA while there is the least proportion of observed noise levels between 45 to 55 dBA. Data collected from bike riders represent 58% and 48% of noise levels between 85 to 95 dBA for non-helmeted and helmeted motorcyclists respectively. Approximately, 39% and 47% of noise readings are observed between 75 to 85 dBA for bike riders without a helmet and with a helmet respectively. In addition, it shows that there are no readings for bike riders observed for the least noise levels i.e., 45-75 dBA, whereas 8% of the observations fall in the highest range of 95 to 115 dBA for bike riders. For car users with open windows, around 87% of noise readings are between 65 to 85 dBA while 13% are above 85 dBA. The data from closed-window cars shows that 59% and 35% of noise levels are observed within the limit of 55 to 65 dBA and 65 to 75 dBA respectively. Furthermore, there are no readings found exceeding the noise level above 75 dBA for the car with closed windows and 5% of the observations are even less than 55 dBA.

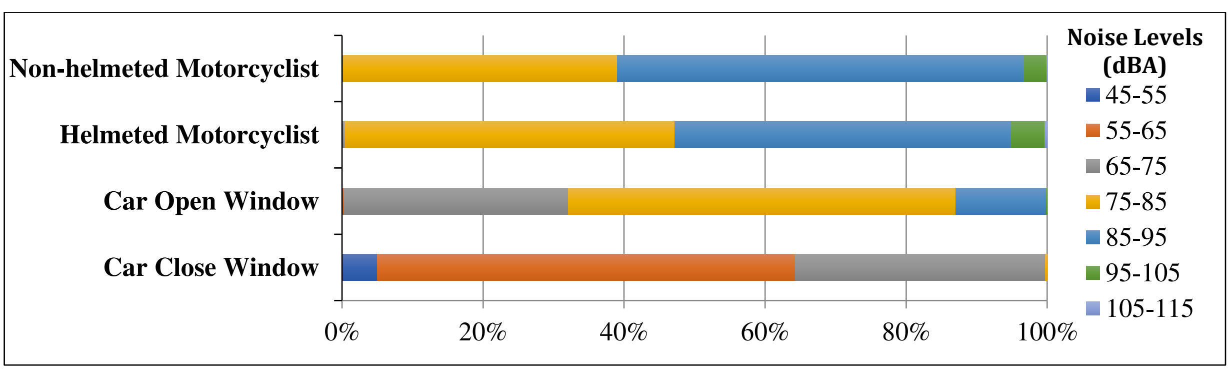

Figure 4 Percentage of noise levels obtained from combined data

Figures 5 and 6 represent the noise levels for the journeys toward and from CBD for the selected road users and compare the observed values with the sensitivity levels provided by Moroe and Mabaso (2022). Figures 5 and 6 are based on an average of 10 seconds of noise level observations. The data shows that the person travelling in a closed-window car is safer from noise pollution in comparison with other modes and scenarios during both journeys. From both graphs, the least value is 52.23 dBA, observed from the car with closed windows during the journey from CBD. While the highest noise of 102.28 dBA for non-helmeted motorcyclists shows the proneness of the motorcyclist to traffic noises. The graphs also show that bike riders irrespective of wearing a helmet are prone to an extreme level of noise, as more than 90% of noise levels are above 80 dBA. The noise levels for open-window car user lies below 80 dBA, which is also close to an extremely dangerous sensitivity level. On the other hand, close window car user readings are nearer to the risky level i.e. 55-60 dBA. The data also shows that there is no significant difference between the noise levels experienced by motorcyclists with or without a helmet.

The actual recorded noise level at 0.5 seconds interval is shown in Figure 7 for the journey from CBD, which shows that the highest recorded noise was observed at more than 110 dBA for motorbikes. This further shows that motorbike riders are always exposed to noise levels of more than 80 dBA, which are classified as extremely dangerous. Furthermore, the noise levels for cars with closed widows were also observed higher than the risky noise level of 55 dBA for most of the journey.

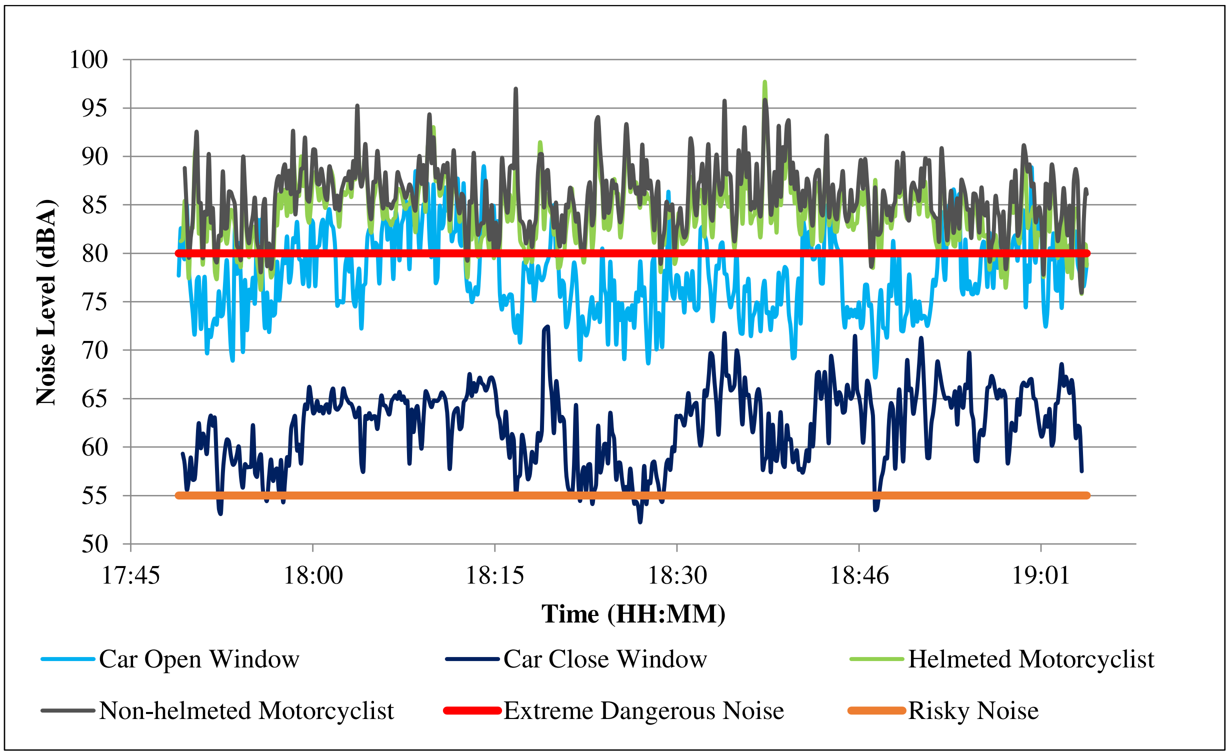

Figure 5 Traffic noise levels for the selected road users during the journey from CBD (10 seconds average)

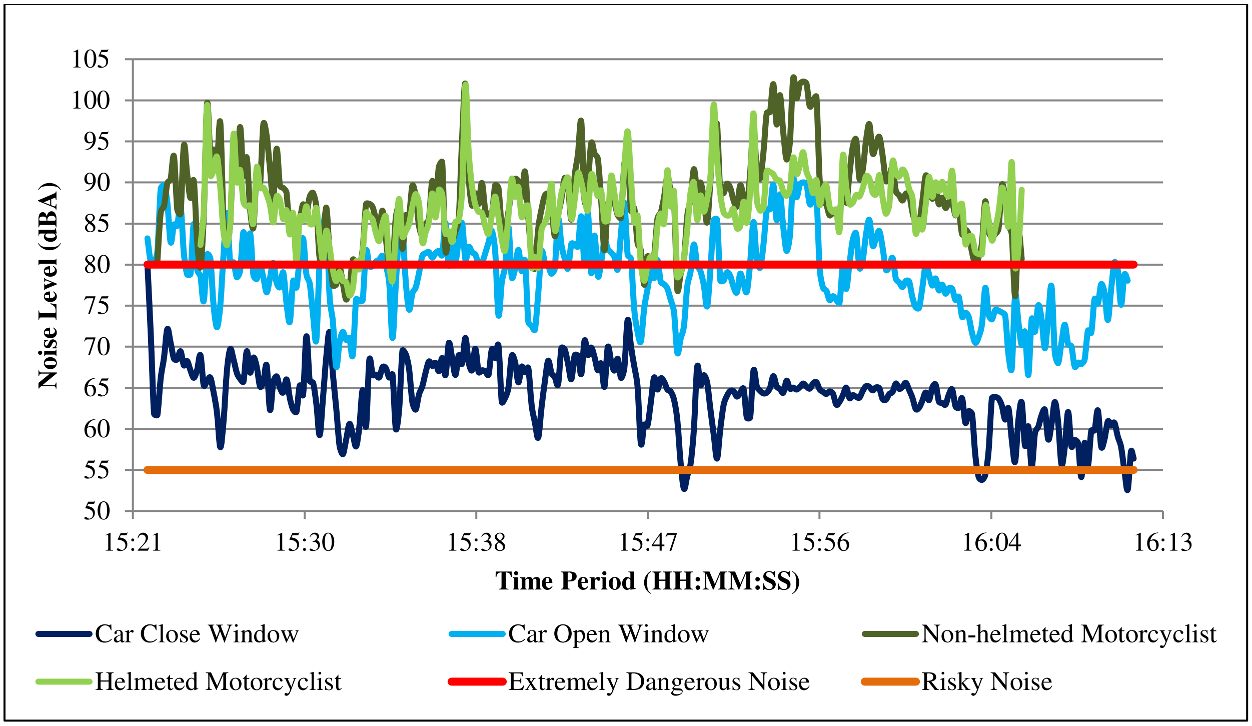

Figure 6 Traffic noise levels for the selected road users during the journey towards CBD (10 seconds average)

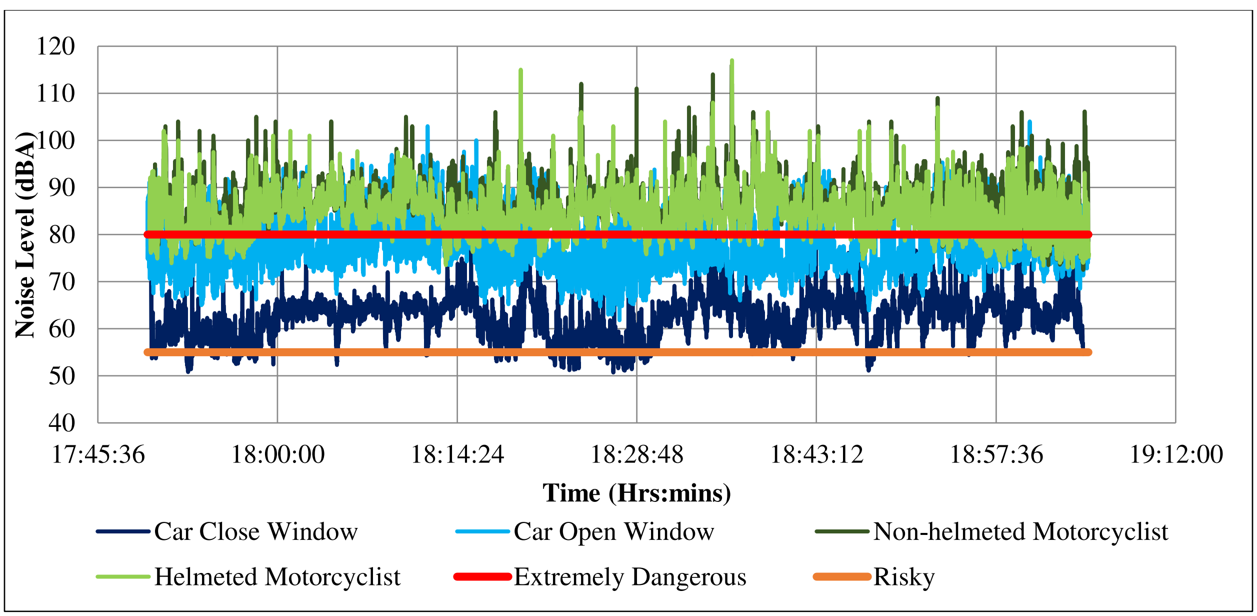

Figure 7 Traffic noise levels for the selected road users moving from CBD (Actual recorded at 0.5-sec intervals)

The exposure of selected road users to traffic noise was classified into various levels of risk using the criteria defined by Moroe and Mabaso (2022). Table 1 shows the classification of data that motorcyclists are exposed to an extremely dangerous level of noise for more than 90% of their journey. On the contrary, the car driver is within safer limits of exposure for 64% time of their journey.

Table 1 Percentage of data collected based on Noise level sensitivity

Noise Level (dBA)	Sensitivity	Motorcyclist		Car	
		Helmeted	Non-helmeted	Close Window	Open Window
Less than 55	-	0%	0%	5%	0%
55–<60	Risky	0%	0%	20%	0%
60–<65	Moderately risk	0%	0%	39%	0.3%
65–<70	Highly risk	0%	0%	30%	5%
70–<75	Dangerous	0.3%	0.3%	5%	26%
75–<80	Highly dangerous	12%	8%	0.2%	34%
>80	Extremely dangerous	88%	91%	0%	34%

As evident from Figure 5, the level of intensity of the sound follows an uneven pattern and appears to be capricious since the ambient noise is an anomalous phenomenon. Therefore, the minimum and maximum values are also presented for the observation period since average values would not be an appropriate representation of the noise levels at any given time. The values of the noise level recorded during both journeys on the selected route for the selected road user groups are presented in Table 2. The table shows the minimum, average and maximum values of noise taken during the study. From the table, it can be found that the noise level a non-helmeted motorcyclist has experienced while riding is the highest of all four scenarios. Hence motorcycle users are more vulnerable and prone to health issues related to noise. Approximately, an average noise level of 86.2 dBA is consumed by non-helmeted bike riders on daily basis. The maximum noise recorded is 110 dBA for non-helmeted bike journeys while the least noise observed is 49.8 dBA for closed-window car journeys. Cars with closed windows provide the safest means of travel from noise pollution with an average noise level of 62.21 dBA during the journey from CBD.

Table 2 Summary of Peak and Off-Peak Noise Levels for Different Scenarios

Modes and Scenarios	Journey toward CBD			Journey from CBD		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Car Open Window	61.8	77.69	101	63.12	78.6	96.68
Car Close Window	51	62.21	75.8	49.8	64.17	81.5
Helmeted Motorcyclist	73.25	84.23	106	74.9	86.81	107.5
Non-helmeted Motorcyclist	73.05	85.82	106.3	74.25	88.16	110

Analysis of Variance (ANOVA) test was performed to statistically test the difference in the average of the noise levels observed for the selected modes. Test results show that the p-value is nearly zero, which means that the null hypothesis (average noise values for the selected modes are equal) can be rejected and the alternative hypothesis can be accepted. Thus, the noise levels for the selected modes are significantly different for each mode.

5. LIMITATIONS AND FUTURE DIRECTIONS

While the present study provides useful insights into road traffic noise from the perspective of roadway users, this study (similar to other studies) is not free from limitations. For instance, the findings from this study are based on the data in Karachi (Pakistan) and could not be generalized to the urban metropolitans in other developing or developed countries due to variations in the traffic mix and behaviour of the roadway users including drivers and motorcyclists. Similarly, the present study has used sedan cars with 1600cc internal combustion engines and the half-face helmet in the experiment. As a part of future research, it would be good to consider different types of cars as well as helmets of different types and to see if there could be a significant change in the in-vehicle or in-helmet noise. This study has not evaluated the effect of traffic volume, speed, and congestion on the noise experienced by road users, which can be a future extension of this study. Furthermore, the present work can be extended to look at the effects of the level of intensity of the in-vehicle and in-helmet traffic noise on the behaviour of the drivers and riders in different weathers and/or seasons. This study also highlights the need to test and improve the design of helmets to protect users from noise and air pollution in addition to protecting them from injuries. The health effects of noise exposure have not been evaluated in this study. A future study may be directed to compare the selected health and psychological parameter of these road users and to quantify the impact of the mode of transport on the health and well-being of different road users.

6. CONCLUSIONS

Noise has various deleterious effects on human health and the daily travel on congested arterials made it widespread among the residents of megacities. The effect of noise on daily commuters may result in terms of high stress, heart diseases, and hearing issues. The urban arterials provide continuous exposure to noise pollution for drivers, passengers, and other road users. This study contributes by looking at the impacts of road traffic noise on roadway users in an urban environment in a more comprehensive fashion while focusing on 1) Drivers in cars with open windows 2) Drivers in cars with closed windows 3) Bike-riders with helmets, and 4) Bike-riders without helmets.

The results show a significant difference in the noise experienced by the commuters travelling in a car with open windows in comparison with the commuters travelling in a car with closed windows. Out of the four road user groups, the commuters travelling in cars with closed windows experience the least noise and were found to be within safer limits for most of the observation period. Whereas, commuters travelling on motorbikes were exposed to an extremely dangerous level of noise for more than 90% of their travel time.

Furthermore, the detailed evaluation of different scenarios shows the vulnerability of bike users in terms of noise. Even though motorcycles take less time to reach their destination due to their easy manoeuvring capability through traffic congestion, the motorbike as a mode of transport poses a high risk due to exposure to noise and accidents. The comparison of noise experienced by motorcyclists wearing and not wearing a helmet was studied as authors were expecting a significant difference in the noise experienced by these two road users. However, the results were surprising that the noise experienced by these two road users had only a minor difference. As the helmets are supposed to protect from injury and the outside environment, this study shows that their impact on noise reduction is not as expected. This further highlights the need of having proper standards for helmet manufacturing so that helmets can protect users from noise and outside air pollution in addition to protecting them from injuries.

This study also shows that road noise observed on the selected route is exceeding 100 dBA at various locations, which also affects inhabitants of the surrounding areas in addition to affecting the road users. The use of horns, the old fleet of vehicles, and the lack of vehicle inspection mechanisms are among the major factors contributing to road noise levels. The lack of public transport is also resulting in the rapid growth of vehicles, especially motorbikes. The road level noise can be reduced by reducing the number of vehicles on road by improving public transport. Furthermore, the vehicle inspection procedures should also include the testing of vehicles for noise. In addition to it, awareness regarding the use of horns could provide drivers with safe journeys for themselves and other roadway users. On the other hand, authorities must take the proper inspection for the noise of older vehicles that could damage the urban environment as well as the ambient environment of drivers.

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Declaration of Interest Statement

The authors report there are no competing interests to declare.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author.

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