ORIGINAL RESEARCH ARTICLE

Traffic Noise Levels and Hearing Impairment Among Shop Keepers in a Metropolitan City – An Embedded Mixed-Method Study

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ABSTRACT

Context: Traffic noise and its impact on shop keepers is studied less. Use of mobile application for assessing noise levels and hearing impairment might provide solution in resource poor settings. **Aims:** Assess hearing impairment in shop keepers of traffic busy roads. Measure the noise exposure and monitor the community noise level in that locality. Find association between noise exposure and level of hearing impairment.

Methods and Material: The study design was embedded mixed method design. It had 1) quantitative phase - hearing impairment among shop keepers, noise level measurements and photographs of study locations were taken, 2) qualitative phase - narrative analysis of the photographs.

Results: Among participants, mean hearWHO score was 49.71 ± 10.95 and 34 had hearing impairment. It is found people who work for more than 10 years had a higher chance of developing hearing loss than those who worked less than 5 years. Weekly averages of noise values exceeded permissible limits in all locations. Narrative analysis suggested increased vehicle density in all locations.

Conclusions: Traffic noise levels are higher than permissible limits mainly contributed by vehicles with potential risk for causing hearing impairment on long term exposure.

Keywords: mhealth, hearWHO, Traffic noise, Hearing loss, Noise pollution, Narrative analysis

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Introduction

World Health Organization estimates at least 700 million or 1 in every 10 individuals will have disabling hearing loss which requires hearing rehabilitation by 2050. Hearing loss of greater than 35 decibels in better hearing ear is referred as disabling hearing loss.[1] National Sample Survey Office (NSSO, 2001) survey suggested that 291 people per one lakh were suffering from severe to profound hearing loss.[2]

One of the reasons for hearing loss is chronic exposure to loud noise.[3] In a study done for evaluation of noise in urban-industrial city Asansol the traffic noise levels exceeded the permissible limit set by Central Pollution Control Board of India.[4] High noise levels have considerable impact on health.[5] Prolonged or repeated exposure to sound levels at or above 85 decibels can cause hearing loss.[6] Long term noise exposure from occupational settings also cause hearing impairment.[7]

Shop keepers, vendors and owner of small shops in busy roads are exposed to noise from traffic. They are more susceptible to chronic noise exposure from traffic. Individuals who spend most of their time in roads with high traffic noise levels have increased chances of developing hearing impairment.[8,9,10] Therefore, assessment of their hearing threshold levels becomes essential.

For assessing hearing damage pure tone audiometry (PTA) is generally used. It is difficult to assess hearing in resource poor settings due to unavailability of PTA and audiologist. The concept of mhealth (mobile health) is also evolving, which is the use of smartphones and mobile applications in medical world for screening, diagnosis, etc. The mhealth provide one of the solutions for screening of diseases in resource poor settings.[11] Using mhealth, the clinical outcome of the patients may be improved.[12] It provide simpler solution for monitoring health by patients themselves at the comfort of their home.[13] The concept of mhealth being cost effective provides economic benefit in resource poor settings.[14,15] One aspect of mhealth is the use of mobile application for hearing assessment.[16]

The World Health Organization published a mobile application called "hearWHO" for assessment of hearing and screening for hearing impairment.[17] The application is available for both android and iOS. The app has user friendly interface and demo on how to use the application. The individual can undergo self-assessment periodically.

The assessment of traffic related noise in major cities is necessary to take adequate measures for planning and monitoring of traffic noise levels.[18] Noise level measurements are done using digital sound level meters or dosimeters. The high cost, lack of availability and requirement of a trained person for the operation of such devices make it difficult to use these devices in poor resource locations. The National Institute for Occupational Safety and Health (NIOSH) published a mobile application called "NIOSH Sound Level Meter"[19] which is used to measure community and occupational noise levels. The free application is available for iOS devices. The application has simpler user interface and clear instructions on how to use the application.

Conventionally the traffic noise index and vehicle density and their contribution to traffic is done manual counting of vehicles for different time intervals. Such analyses were done by comparing the video recording of the vehicles traveling in roads in traffic junction and counting vehicles crossing the roads.[20] This information on types of vehicles contributing to road traffic, their patterns and variations, can be studied by narrative analysis of the photographs of the roads and vehicles taken in these locations for a period.

Methodology

The study design used was Embedded Mixed Method Design, were a quantitative phase which included hearing assessment in shop keepers and measurement of community noise levels followed by the qualitative phase which included narrative analysis of the photographs of the roads taken during community noise level measurements. Ethical clearance was obtained on 05.09.2023 from the Institutional Ethics Committee Government Medical College, Omanduar Government Estate (IEC NO: 81/IEC/GOMC/2023). Informed written consent was obtained from the participants. The data was entered in Microsoft Excel sheet and data cleaning and missed data finding were done. The data were analysed using Statistical Package for Social Sciences (SPSS) version 29.

Hearing assessment in shop keepers

The shop keepers, salesmen, cashiers of shops located in busy roads with high traffic noise levels were selected for the study. The minimum sample size required was calculated using formula, $N = [Z^2 * P(1-P)]/E^2$, where N is sample size, P is population proportion, Z is z score and E is allowable error. The prevalence of hearing impairment was found to be 6.3%[2], with 95% confidence interval, 5% allowable error and 10% non-response rate the sample size arrived was 91. Systematic Random Sampling method was followed during data collection and hearing assessment. the study was conducted for 2 months between September and October 2023. The demographic data of the participants were collected using a questionnaire which included information like name, age, occupation. Further the questionnaire had questions regards their education qualification, work experience and hours of work. It also included question regarding previous history of ear pain, ear discharge, ear surgery, to exclude person with obvious hearing impairment.

For assessing the hearing ability of the participants, the mobile application by World Health Organization called hearWHO (https://www.who.int/teams/noncommunicable-diseases/sensory-functions-disability-and-rehabilitation/hearwho) was used. The app via headphone presents 23 sets, with each set containing three digits in English one by one, the person must enter the three digits of present set before proceeding to next set. As the sets progresses the background noise increases, if it is very difficult for the person to clearly understand he can guess the number, it need not be correct. The application uses digits in noise technologies. It is a screening tool for hearing, which gives scores from 0-100 based on person's ability to perceive speech (digits) in background noise using headphones. The sensitivity and specificity of the app is over 85%. The screening determines signal to noise ratio (SNR) Which is indicative of hearing ability. Score >70 means good hearing, scores between 50-70 require regular hearing checkup, while score <50 indicate some hearing loss. Though the investigator had provided mobile with application installed and headphones with earbuds changed after each use, the participants were encouraged to install the app and use their headphones. After obtaining Consent, the participants were interviewed using questionnaire and explained about the test and then test was conducted. Though the test can be performed in low to moderate ambient noise, quite place was preferred during testing. The data were then entered in SPSS software. Then descriptive analysis and multivariate analysis by logistic regression based on the model - presence or absence of hearing impairment according to hearWHO scores was done.

Study area for community noise level measurement: In the study area, 8 locations were chosen which are the major traffic intersection surrounding the institute. It covers an Entertainment zone (location 1), Market place (location 8), Hospital zone (A-Block - Location 5 and 7, B-Block - Location 2,3 and 4), Major traffic junction (Location 5 and 7), School zone (Location 6). In the given locations noise level measurements were taken during Morning, Afternoon, Evening and Night hours.

The time intervals between which the measurements were taken were, Morning (8.00 a.m-9.00 a.m), Afternoon (12.00p.m-2.00 p.m), Evening (4.00p.m-6.00 p.m), (Night 8.00 p.m-9.00 pm). The noise level measurements were taken for a period of one week from 11.10.2023 to 17.10.2023. There were no public holidays in the week during measurements. There was no drastic climatic change cyclone or heavy rain fall during the week, which may interfere with readings measured. The noise standards as notified in Environment (Protection) Rules,1986 by Committee on Noise Pollution Control constituted by Central Pollution Control Board (CPCB) were, code A- Industrial area [day-75 dB(A) and night-70 dB(A)], code B-Commercial area [day-65 dB(A) and night-55 dB(A)], code C-Residential area [day-55 dB(A) and night-45 dB(A)], code D-Silence Zone [day-50 dB(A) and night-40 dB(A)], with day - 6 a.m to 9 p.m, night - 9 p.m to 6 a.m, Silence Zone include areas within 100 meters of hospitals, educational institutions and courts.

Application for community noise level measurement: The noise level measurements were done using a mobile application called NIOSH Sound Level Meter, developed by National Institute for Occupational Safety and Health (NIOSH), which is a part of Centers for Disease Control and Prevention (CDC). NIOSH is a research agency aimed at improving worker safety and health. The accuracy of the measurements lies within ±2 dBA. It meets Type 2 requirements of IEC 61672:3 SLM standard with calibrated external microphone. In this study the inbuild internal microphone of the device is used, as the study aimed studying the efficacy of the application in hands of an unexperienced individual. An iphone XR, was used for data collection. The application was installed, and the instructions were read. During measurements, the device was held about 1.5 meters from ground level within 30 centimeters from head with internal microphone pointing towards the road. The application was made to run for about 1 to 2 minutes in each location and measurements were recorded. The metrics measured were LAeq, Max. level and TWA (8 hour-Total Weighted Average). The data was entered in Microsoft Excel sheet; data cleaning and missing data finding were done. Then the data were entered in SPSS software for analysis.

Photographs for Narrative Analysis: The photographs of the roads in the intersection in the 8 locations were taken during noise level measurements were taken using smartphones. Aerial view photographs of the roads were taken from the top of the buildings in possible locations. The photographs were then compiled according to time and locations. Then manual narrative analysis of the photographs from different locations and time was done. Manual coding of the photographs was done and factors contributing to traffic like vehicle types, traffic characteristics, key trends and themes were arrived.

Results

Hearing Assessment: There were 105 participants in the study. Out of 105 participants in the study 103 were male (98.09 %) and 2 females (1.91 %). The mean age was 30.46 ± 12.9. The mean hearWHO score was 49.71 ± 10.959. The mean years of work was 7.1 ± 7.885 years. The mean hours of work were 9.8 ± 1.958 hours. The number of shopkeepers with hearWHO of >70 was 5(4.76 %) with mean hearWHO score of 84 ± 8.9442, number of shopkeepers with hearWHO score of 50-70 were 66 (62.85 %) with mean hearWHO score of 52.42 ± 5.5637 and number of shopkeepers with hearWHO score of <50 was 34 (32.38 %) with mean hearWHO score of 39.41 ± 2.3883.

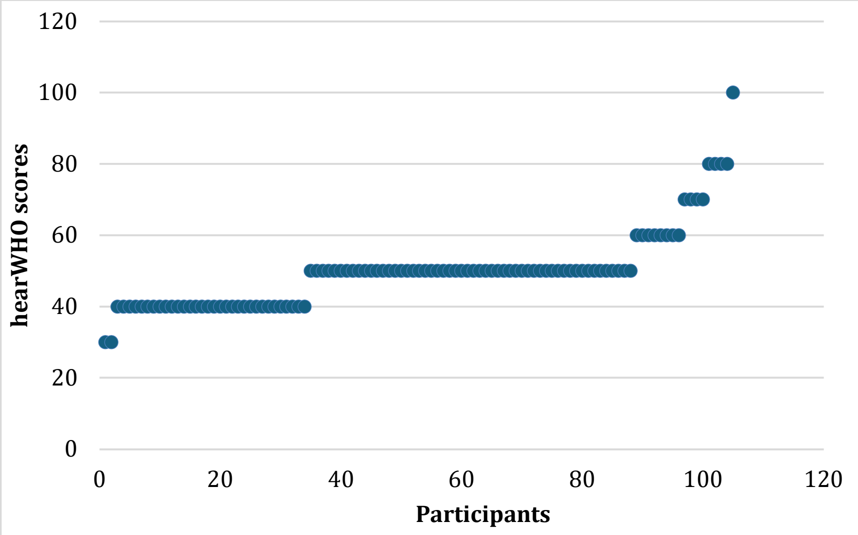

Figure 1: Distribution of hearWHO scores. Y axis-hearWHO scores, X axis-Participants.

Table 1: Distribution of hearing impairment by sociodemographic characteristics

Characteristics	hearWHO score <50 (%)	hearWHO score >=50 (%)	Chi square	P-value
Age				
<_20	6 (17.64)	18 (25.35)	3.692	0.296
20-30	13 (38.23)	32 (45.07)		
30-40	5 (14.7)	11 (15.49)		
>40	10 (29.41)	10 (14.08)		
Education				
<Secondary school	7 (20.58)	9 (12.67)	1.676	0.642
Secondary school	7 (20.58)	19 (26.76)		
Higher secondary school	5 (14.7)	14 (19.71)		
Graduate	15 (44.11)	29 (40.84)		
Years of work				
<5	15 (44.11)	31 (43.66)	10.182	.006*
5-10	6 (17.64)	30 (42.25)		
>10	13 (38.23)	10 (14.08)		
Hours of work per day				
<8	13 (38.23)	19 (26.76)	1.384	0.384
8-10	11 (32.35)	32 (45.07)		
>10	10 (29.41)	20 (28.16)		

*Statistically significant

Table 2: Distribution of hearWHO scores by sociodemographic factors

Characteristics	hearWHO score (mean ± SD)	P-value
Age		
<_20	51.25 ± 11.156	0.364
20-30	50 ± 9.770	
30-40	49.375 ± 9.979	
>40	47.5 ± 14.095	
Education		
<Secondary school	46.87 ± 10.781	0.643
Secondary school	51.15 ± 12.752	
Higher secondary school	48.42 ± 8.342	
Graduate	50.45 ± 10.987	
Years of work		
<5	49.56 ± 10.318	0.015*
5-10	53.05 ± 13.053	
>10	44.78 ± 5.931	
Hours of work per day		
<_8	48.75 ± 12.889	0.612
8-10	50.46 ± 9.747	
>10	49.66 ± 10.661	

*Significant

The distribution of hearing impairment (hearWHO score <50) among different categories based on various characteristics were given in table 1. A notable trend was observed in years of work category were "<5 years" has highest percentage of individuals with a hearWHO score <50 (44.11%), followed by ">10 years" (38.23%), and then "5-10 years" with a considerably lower percentage (17.64%). This result indicates a statistically significant association between years of work and hearing impairment. This suggests that the duration of employment might play a role in hearing impairment, though the relationship is not linear.

Distribution of hearWHO scores by sociodemographic characteristics (age, education, years of work and hours of work) were given in table 2. There's a trend towards lower mean hearWHO scores with increasing age, though it is not statistically significant.

Multivariate analysis was done by logistic regression based on the model - presence (hearWHO score <50) or absence (hearWHO score >=50) of hearing impairment according to hearWHO scores for the following variables 1)Age 2) Education 3) Years of work 4) Working hours per day, under different categories were given in table 3.

Community Noise Levels: The community noise level measurement averages of morning, afternoon, evening and night hours in 8 locations and the overall weekday and weekend average noise levels, LAaq, dB(A) was given in table 4. The noise levels were above recommended levels in most of the locations.

Narrative Analysis: Narrative analysis by manual coding of the photographs taken during noise level measurements at 8 locations during weekdays and weekends was done and key themes identified was Traffic Congestion at Leisure Zones, Peak Traffic Flow During School Commute Hours, Sustained High Traffic Volume in Commercial Zones, Traffic Volume Fluctuation in traffic junctions.

Table 3: Bivariate and multivariate analysis using logistic regression model

Variables	n	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	P-value
Age				0.718
Age <=20	24	Ref(1)	Ref(1)	-
Age 20-30	45	0.17 (0.01-1.11)	1.78 (0.28-11.15)	0.538
Age 30-40	16	0.21 (0.02-1.96)	1.01 (0.22-4.61)	0.994
Age >40	20	3.00 (0.38-8.36)	1.79 (0.38-8.36)	0.459
Education				0.854
<secondary school	16	Ref(1)	Ref(1)	-
Secondary school	26	2.11 (0.737-6.045)	.61 (0.14-2.73)	0.520
Higher secondary school	19	2.18 (0.670-7.08)	1.23 (0.37-4.10)	0.732
Graduate	44	1.50 (0.62-3.63)	1.12 (0.32-3.99)	0.856
Years of work				0.017*
<5	46	Ref(1)	Ref(1)	
5-10	36	2.42 (0.937-6.24)	2.21 (0.53-9.26)	0.278
>10	23	0.37 (0.16-0.87)	7.532 (1.80-31.54)	0.006*
Working hours per day				0.713
<=8	32	Ref(1)	Ref(1)	-
8-10	43	1.99 (0.85-4.68)	.78 (0.25-2.49)	0.676
>10	30	0.25 (0.04-3.92)	1.25 (0.40-3.92)	0.709

* p< 0.05 - Statistically significant, OR- Odds Ratio, CI- confidence interval. Multivariate analysis using logistic regression analysis based on characteristics like age, education, years of work and working hours per day, n= of participants per Category. P- values: Overall p- value for variable (likelihood ratio test); Category p- values for Adjusted ORs.

Table 4. Average noise levels in 8 locations during different hours of the day and average noise levels calculated for a total of one week in 8 locations.

Locati on	Weekday averages (LAeq). (Monday to Friday)				Weekend averages (LAeq). (Saturday and Sunday)				Weekday average LAeq,dB(A)	Weekend average LAeq,dB(A)
	Morning	Afternoon	Evening	Night	Morning	Afternoon	Evening	Night		
1	74.12	79.96	78.56	77.1	78.5	74.05	75.5	82.1	77.45	77.53
2	73.24	77.28	75.16	78.54	77.05	69.05	76.1	74.8	76.05	74.25
3	76.38	76.76	75.62	77.98	76.3	77.15	77.25	77.55	76.68	77.06
4	79.88	79.48	79.38	78.66	78.9	80.7	76.3	79.25	79.35	78.77
5	80.82	83.26	80.44	81.32	81.35	79.9	83.1	80.7	81.46	81.26
6	79.2	78.36	81.5	76.26	81.6	76.1	75.7	81.7	78.83	78.77
7	81.42	80.28	82.38	82	79.65	79.8	82.35	77.55	81.52	79.83
8	78.72	79.48	77.2	78.28	78.15	82.5	78.4	79.3	78.4	79.62

DISCUSSION

Hearing assessment: The prevalence of hearing impairment among shop keeper the in present study was 32.38%. In a previous study done by Mogan *et al*, using the same application for assessing hearing impairment in college students the prevalence was 9.4%.[21] Which is much lower probably due to the reason that their sample consisted only college students below 25 years of age and the present study includes all age groups and a high-risk population. In another study by Garg *et al*[22], the prevalence was 25.1% which is done in general population using conventional methods of hearing assessments which is still lower than present study probably due to the reason that sample in the present study was obtained from high-risk population (shop keepers and vendors in busy traffic roads). Similarly in a case-control study by Wang TC *et al*[10] it is found that prevalence of hearing impairment is more in person expose to traffic noise [10] than control group.

It is observed in table 2, that mean hearWHO score decreases as the age group increase which is also supported by the study by Cruickshanks *et al*[23] which suggested linear relationship between increasing age and hearing impairment.

Table 5: Key characteristics and themes arrived by narrative analysis

Location	Day of Week	Traffic Characteristics	Dominant Vehicle Types	Key Codes	Emerging Theme
Beach Area	Weekend	High vehicle & pedestrian density	Auto-rickshaws, Cars	High vehicle density, pedestrian activity, evening, weekend	Traffic Congestion at Leisure Zones
	Weekday	High vehicle density		High vehicle density, evening, weekday, consistent traffic flow	
School Zone	Weekday	High pedestrian, moderate vehicle density	Auto-rickshaws, Cars, Motorcycles	High pedestrian density, moderate vehicle density, weekday, morning	Peak Traffic Flow During School Commute Hours
	Weekend	Lower vehicle density		Lower vehicle density, weekend, morning, minimal activity	
	Weekday	Moderate vehicle & pedestrian density		Moderate vehicle density, pedestrian activity, weekday, evening	
	Weekend	Lower vehicle density		Lower vehicle density, weekend, evening, decreased activity	
Market Place	Weekday	High vehicle density	Auto-rickshaws, Cars, Buses, Motorcycles, trucks	High vehicle density, night, weekday, commercial activity	Sustained High Traffic Volume in Commercial Zones
	Weekend	High vehicle density		High vehicle density, night, weekend, sustained activity	
	Weekday	High vehicle density		High vehicle density, morning, weekday, market activity	
	Weekend	High vehicle density		High vehicle density, morning, weekend, consistent market activity	
Major Traffic Junction	Weekday	High vehicle density	Auto-rickshaws, Cars, buses, Motorcycles, trucks	High vehicle density, major road, weekday, morning, heavy traffic	Traffic Volume Fluctuation in traffic junctions
	Weekend	Moderate vehicle density		Moderate vehicle density, major road, weekend, reduced congestion	
	Weekday	High vehicle density		High vehicle density, major road, weekday, evening, rush hour	
	Weekend	Moderate vehicle density		Moderate vehicle density, major road, weekend, evening activity	

In table 2, there is a statistically significant association between the number of years worked and hearing impairment (p=.006) and the distribution of hearing impairment differs significantly across the different years of work categories. The lowest mean hearWHO score was for group who worked for more than 10 years suggesting that long term exposure to loud noises can cause hearing impairment, which is similar to the study by Feder *et al*[24]. It is observed that the participants who had not completed secondary education had the lowest mean hearWHO score when compared with those who have completed secondary school or higher, similar findings were reported in the study by Cruickshanks *et al*[23] that prolonged noise exposure causes impairment in people with lesser education than who had 16 years or more of education. The probable reason could be early employment than those who have more education and had late employment indirectly suggesting long years of work.

The community health workers play a major role in community screening and use of mhealth applications by them provide effective interventions.[25] In the study by the Yousuf Hussein S *et al*, use of mhealth applications for hearing screening by Community health workers aided in early referral of people at to higher centres.[26]

The logistic regression analysis showed that there is statistically significant difference between participants worked <5 years (p = .017) and >10 years (p = .006) and the odds of hearing impairment in shopkeepers working >10 years are 7.532 times higher than those working less than 5 years. This strongly suggests that longer duration of exposure to traffic noise is a significant risk factor for hearing impairment.

Community noise level measurements: The noise level measurements of 8 locations were done four times a day. The mean noise level values provide an overall view of noise burden in the locations. On weekdays the lowest and the highest mean noise level values were 73.24 and 83.26 observed in location 2 morning and location 5 afternoon respectively. On weekends the lowest and the highest mean noise level values were location 2 afternoon and location 5 evening respectively. The lowest and highest overall weekday mean noise level value were 76.05 and 81.52 measured in location 2 and location 7 respectively. During weekdays all mean noise level value exceeded 70 dB(A) mark, with locations 5 and 7 exceeding 80 dB(A) mark. The lowest and the highest overall weekend mean noise level values were 74.35 and 81.26 in locations 2 and 5. Out of all mean noise level values only one was below 70 dB(A) (location 2 afternoon).

The WHO guidelines for community noise level in commercial and traffic areas is 70 Leq dB(A) with time base 24 hours and LA max, fast (dB) is 110.[27] The overall weekday and weekend mean noise level values exceed this limit in all locations. Similarly in the study in Kolhapur, Maharashtra[28] showed that community noise levels exceed WHO guidelines in that city. The guidelines for school zone less than 55 Leq dB(A)[27] during playtime and the levels got exceeded in location 6 (School Zone).

Though conventional dosimeters and sound level measurement devices are superior and more accurate in measuring noise levels, its cost and requirement of operating skills makes it difficult for public to use it regularly. The strength of this study was the use of a mobile application with simple user interface for the measurements of community noise levels.

Narrative analysis using photographs: Narrative analysis was done using photographs taken during noise level measurement in each location. Using the photographs taken, the information about type of vehicles, their contribution to traffic, mode of transport preferred by people and vehicle variation during weekday and weekend in specific locations and other relevant details were obtained. These photographs were then compared, and relevant data were obtained. The 8 locations comprised entertainment zone (beach), Market area, School zone, Major traffic junction, and Hospital zone.

Entertainment zone (location 1): The entertainment zone in location 1 was beach. Apart from being entertainment zone, the road serves as a major route for people as it connects many important locations. It is observed that during morning and evening hours of the weekdays the road was mostly used by people to reach their workplace and back home, thereby considerable increase in number of vehicles was observed during those times. The vehicle density was contributed by two wheelers, cars, buses and autos. During afternoon the road had a considerable decrease in vehicle density during both weekdays and weekends. During weekends the evening and night hours had higher vehicular density

Market area (location 8): It is observed that contribution to road traffic was majorly by autos, two wheelers and cars. Other vehicles which contributed to traffic include buses and trucks. It is observed that traffic levels in market area were lower during weekends compared to weekdays. The crowding of people in marketplace was also evident from the photographs which may also contribute to the elevation of ambient noise levels

School zone (location 6): The morning and evening hours had the high number of vehicles corresponding with school timings, compared with afternoon and night hours. The weekdays had higher number of vehicles when compared with weekends throughout the day. This road not being a major bus route had cars and two wheelers as major contributor to vehicle density followed by autos.

Major Traffic Junction (locations 5 and 7): It is observed that during weekdays, morning, evening and night hours had higher vehicle density. During weekdays the number of two wheelers, cars and autos present during morning and night hours were more. The number of buses during morning and evening hours was relatively high, probably to occupy increased number of passengers during peak hours. Buses, trucks and autos majorly contributed to vehicle density during afternoon and evening hours. During weekend, the vehicular density during the day was lower, while a considerable increase in number of two wheelers, cars and autos is observed during night.

Hospital zone (A-Block - location 5 and 7, B-Block - location 2, 3 and 4): The hospital zone under study includes A-Block and B-Block. The vehicle density was lower in weekends when compared with weekdays. The vehicle density is contributed by two wheelers, cars, autos and buses.

LIMITATIONS

In the study the noise exposure from the traffic was considered but the participants other recreation noise exposure was not included. The hearWHO application works best in silent environments using the app in community settings may affect results. Currently, the NIOSH application is available only for iOS devices. Further this study didn't consider the effects of pressure, humidity and temperature changes which may interfere with the sound measurements. Further the application was only made to run only for 1 to 2 minutes in each location owing to time constraints. Use of external microphone may increase the accuracy of measurements, but the study used the inbuilt microphone to mimic resource poor setting. Measuring for longer duration during each measurement could possibly increase the overall accuracy of the application. Applications didn't have native language options during study.

Conclusion

This study was set out to examine the effect of community noise levels on hearing impairment. The study used the concept of mhealth. The results indicate traffic noise levels are higher than permissible limits in study locations, mainly contributed by vehicles. People who had long term exposure to traffic noise had significant hearing impairment. The findings suggest that measures for traffic noise control and limiting personal exposure is necessary to prevent hearing impairment. Time constraints were limitation and future studies may employ longer study duration.

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