Noise level in recreational areas in Mekelle, Ethiopia:ross-sectional study

Yilkal Zemene Tassew,* Josh P. Wiedermann

Affiliations:

1. ENT and head and neck surgeon, St Paul's Hospital millennium medical college, Addis Ababa, Ethiopia
   Email: yilkal.zemene@sphmmc.edu.et
   Alternative email: yilikalzt@gmail.com
   ORCID: 0000-0001-8919-5913
2. Senior Associate Consultant
   Assistant Professor of Otolaryngology-Head and Neck Surgery, Mayo Clinic, Rochester
   Phone: 507 284-2544
   Medical Admin Assistant: 507 538-0090
   Email: Wiedermann.joshua@mayo.edu

Correspondence *:
Yilkal Zemene Tassew, St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

Publication information

Received: 13-December-2021

Accepted: 17-December-2021

Published: XX-January-2021

Citation: Yilkal Zemene Tassew and Josh P. Wiedermann. Noise level in recreational areas in Mekelle, Ethiopia: A Cross-Sectional Study. MJH, 2022, Volume 1(1): e-ISSN: 2790-1378.

Abstract

Background: Noise-induced hearing loss is the most common cause of sensorineural hearing loss following presbycusis. Excessive noise exposure can often occur while attending leisure activities in bars and restaurants. According to the United States Occupational Safety and Health Agency, the noise exposure should not exceed 85 decibels (dB) in 8 hours working period per day, nor 95 decibels for just two hours.

Methods: We conducted a prospective cross-sectional study and measured the noise level in forty-three bars, restaurants, and music clubs in Mekelle, Ethiopia. The measurement was done around 10:00 pm and midnight in each of the selected houses.

Result: The study showed the mean loudness of 97dB for 10:00 pm while it is 101dB for -mid-night time, with a standard deviation (SD) of 3 dB and 7 dB, respectively. The maximum loudness measured was 107 dB and 108 dB, respectively.

Conclusion: According to international standards, many institutions locally surpass exposure limitations. We suggest that regional and national regulations be placed to limit exposure and protect the workforce of Ethiopia.

Keywords: Ethiopia, Hearing loss, Leisure activities, Music, Noise

Background

Noise-induced hearing loss (NIHL) is the second most common sensorineural hearing loss, next to presbycusis, and is the most common preventable cause of hearing loss. It has a multitude of possible causes and risk factors including traumatic impulse sounds and repeated exposure to high-intensity sounds.[1] Noise-induced hearing loss significantly affects the quality of hearing in many ways including resolution and sensitivity.[2] It has been suggested that 12% or more of the global population is at risk for hearing loss from noise, which equates to well over 600 million people.[3] The World Health Organization (WHO) estimates that one-third of all cases of hearing loss can be attributed to noise exposure.[4]

The focus on acoustic trauma problems has largely been related to adults who are exposed to loud noise from battlefields, noisy industrial factories and in the elderly, for whom a lifetime of noise exposure can hasten the onset of presbycusis. [5] Although occupational noise has decreased since the early 1980s, the number of young people subject to social noise exposure has tripled. [6] Since the advent of amplified sound in the music and entertainment industries, and the growing popularity of portable music and gaming devices among the younger population, noise-induced hearing loss in children and young adults is becoming a serious and growing concern. [7]

Noise can cause permanent hearing loss at chronic exposures equal to an average sound pressure level (SPL) of 85 decibels (dB) or higher for eight hours. [8] Based on the logarithmic scale; a 3-dB increase in SPL represents a doubling of the sound intensity. Therefore, four hours of noise exposure at 88 dB is considered to provide the same noise “dose” like eight hours at 85 dB, and a single gunshot, which is approximately 140 to 170 dB, has the same sound energy as 40 hours of 90-dB noise.[9] Occupational noise-induced hearing loss causes sensorineural hearing loss in industrial workers who are continuously exposed to high-frequency noise due to degeneration in hair cells and associated nerve fibers.[10]

Studies showed the mechanism of injury to the inner ear to cause hearing loss and other symptoms caused by noise as either mechanical or metabolic. Mechanical destruction is acquired by exposure to noise intensities above 130 dB SPL leading to disassociation of the organ of Corti from the basilar membrane, disruption of cell junctions, and mixing of endolymph and perilymph.[11] The pathology observed as a result of metabolic decompensation includes stereocilia disruption, swollen nuclei, swollen mitochondria, cytoplasmic vesiculation, and vacuolization.[12] This noise trauma can result in two types of injury to the inner ear, depending on the intensity and duration of the exposure: either transient attenuation of hearing acuity a.k.a. temporary threshold shift, or a permanent threshold shift.[13]

An objective examination of a sensorineural hearing loss(SNHL)is audiometry and in people with noise exposure, it is shown that the loss at 4 kilohertz (KHz) is more reliable than 6 KHz notch.[14] Even though the protective effect of unilateral and bilateral earplugs on noise-induced hearing loss has been proved with functional and morphological evaluation in an animal model,[15] very few people use hearing protective devices during recreational and workplace noise exposure in Ethiopia. There are some environmental and personal factors that decrease the use of Hearing Protection Devices (HPD).[16] Controversies arise on the effectiveness of most HPDs used. People who use the HPD are mostly not using it correctly and consistently.[17] A research showed that among people who attended recreational exposure to loud athletic and entertainment events; only 8% of respondents reported consistent use of HPDs at these types of events.[18]

Distortion product otoacoustic emission (DPOAE) signal strength alone cannot indicate preclinical NIHL in adolescents.[19] Extended high-frequency audiometry seems able to identify the first signs of NIHL, much earlier than conventional audiometry, and therefore may need to be implemented in the screening examinations especially of workers with less than 1 decade of employment. Hearing screening protocols could become more efficient by adjusting their frequency ranges according to the frequencies "at-risk", which correspond to the duration of the workers' previous employment.[20] Ethiopia’s young population has the habit of going to recreational centers regularly that boast environments that make it very difficult to hear the conversation of those around you.

Knowing the noise levels in recreational areas will help to inform the local regulator office to have evidence-based policy-making which protects the health of the society and people working in those specific places. It is also a critical step to increase the awareness of society about the ever-increasing noise-induced hearing loss.

Materials and methods

Study design and period

The study is a prospective cross-sectional study where data is collected from the study areas with a standard calibrated digital sound level meter. The data collection was conducted from November 4 to December 26, 2019 G.C.

Study area and study population

The study was conducted in Mekelle City, the Capital city of the Tigray Regional State. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), this town has a total population of 215,914 people (104,925 men and 110,989 women). However, currently, an estimation of more than half a million population is expected to live there. Our source areas are bars, pubs and cultural traditional houses located in the city. Houses were located in three of the seven different -sub-cities of Mekelle City, as they are known for nightlife. We excluded those bars without discotheque service and those which people prefer for a quiet environment.

Sample size and sampling methods

Secondary to the availability of the limited number of nightclubs and traditional cultural houses in the city, we used non-probability sampling. This cross-sectional study includes sampling in the three common sub-cities known for leisure time activities.

Data collection and analysis

The noise level in the selected houses was measured using the dosimeter manually. An average level was taken after several measurements. Two well-trained data collectors went to the selected pubs and traditional cultural restaurants and used the calibrated dosimeter to measure the loudness of the environment in the room. The places were visited twice during the study period to measure the noise level at the beginning (around 10:00 pm) and the middle (around midnight) of the evening. The measurement was done around the center of the room. Informal interviews were done to estimate the time patrons spend in the places.

The collected data was entered and analyzed by statistical package for the social sciences(Statistical Package for Social Science version 25 statistical software.

Ethical considerations

The ethical clearance was obtained from the research and ethical committee (REC) of Mekelle University-College of Health Sciences.

Results

The results are based on data collected in 43 bars, night clubs and traditional restaurants with live music. Most bars use amplifiers put on each corner of the bar except one traditional restaurant with live music which has the amplifier only around the stage. The lowest decibel level was 34 dB for the early evening and 95 for midnight. The maximum loudness measured was 107 dB and 108 dB, respectively. The mean loudness for 10:00 pm is 97 dB while it is 101 for midnight, with a standard deviation (SD) of 3 and 7 dB, respectively.

From our informal interviews with patrons and employees, the average time club and bar goers spend in one place is at least 2 hours and employees spend a minimum of 5 hours per day with five days a week shift. This raw data was changed to time weight average (TWA) for 8 hours according to Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) standards. The earlier standard TWA of 88 dB and 90 dB for the early evening and midnight measurements while the NIOSH give us 92 and 95 dB, respectively. The interquartile range of the noise level showed between 94dB and 102 dB with one outlier in the 10:00 pm recording, with increases between 98 dB and 105dB during the midnight recordings (Figure 3 & 4). The summary of our numeric data analysis is summarized below (Table 1). During data collection time, we observed that none of the bartenders working in the study subjects were using hearing protection devices.

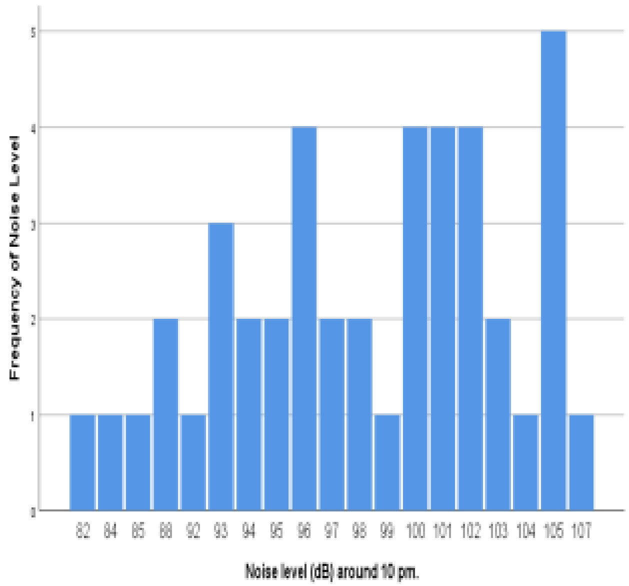

Figure 1: The frequency of each Noise level was measured in recreational areas in Mekelle, Ethiopia, 2019 (n=43)around 10 post meridiem (PM)

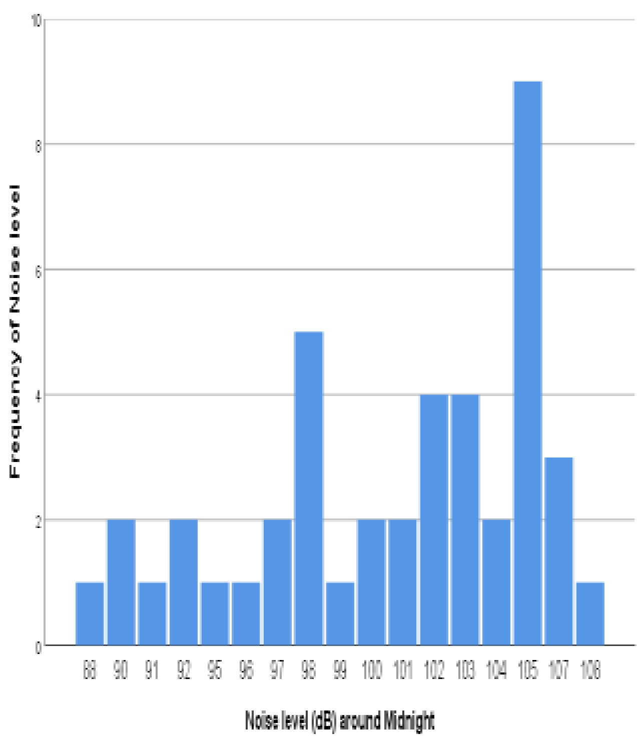

Figure 2: The frequency of each Noise level Measured in recreational areas in Mekelle, Ethiopia, 2019 (n=43) around midnight

Discussions

To our knowledge, our research is the first to study the noise level of nightclubs and bars in Ethiopia. There are few studies done on the noise magnitude around markets and worship places. [21,22,23] Even though people go to such places for social gatherings and entertainment, a significant percentage of patrons complain about the excessive noise. Excessive noise is defined as being unable to talk to somebody an arm's length away from you with a raised voice.[24] Globally OSHA and NIOHS are two well-accepted noise regulation standards. OSHA works on law and regulation reinforcement. It puts an equivalent noise level (Leq) of 90 dB as maximum permissible dose with 5dB doubling while NIOSH works on research and hearing loss prevention recommendations put 85 dB as maximum exposure level (MEL) with 3dB doubling.[25]

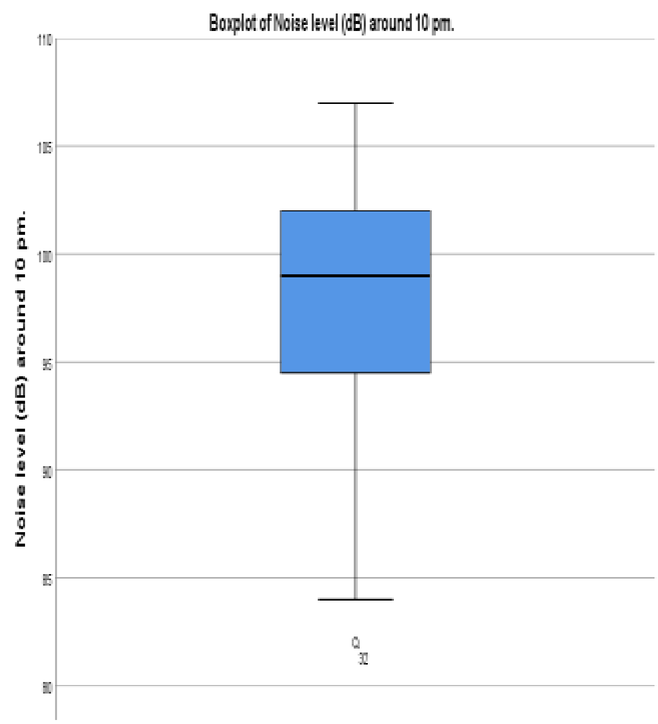

Figure 3: Boxplot of the Noise level (in decibel) measured in recreational areas in Mekelle, Ethiopia, 2019 (n=43) around 10 post meridiem (PM).

Cohen and Welch expressed the loudness of bars and restaurants in their papers with similar results to ours. [26,27] The International Labor Organization (ILO) recommends a maximum of 85 dB for an average 8 hour working shift. Our study showed Leq of 92 dB and 95 dB at early evening and late-night, this amount of decibel is safe for an exposure of 1 hr. 35min. and 47 min. 37sec respectively. This suggests that bartenders and patrons are at clear risk of NIHL.

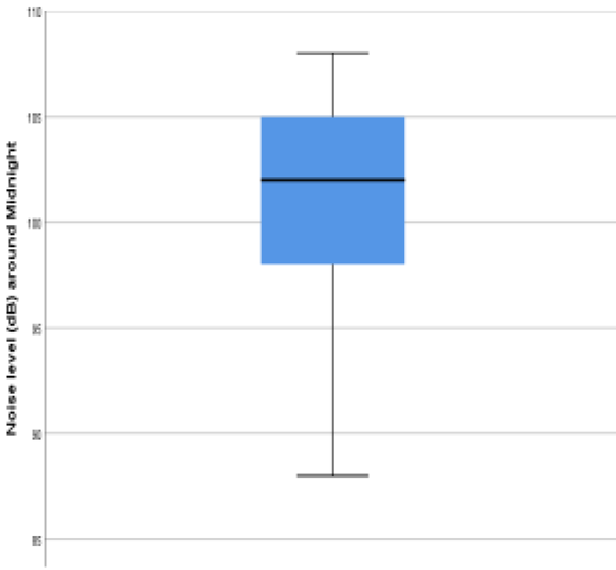

Figure 4: Box plot of Noise Level (in Decibel)measured in recreational area in Mekelle,Ethiopia,2019 (n=43) around midnight.

Table 1: Descriptive findings of the statistical analysis

Measures		**Noise level (dB) 10 pm.**	**Noise level (dB) Midnight**
Mean		97.74	100.49
Median		99.00	102.00
Mode		105	105
Std. Deviation		6.028	5.221
Minimum		82	88
Maximum		107	108
Percentiles	25	94.00	98.00
	75	102.00	105.00

Previous research associates a high risk of SNHL with loud sound exposure. The impact of the loud noise on the hair cells of the cochlea depends on the total energy exposure. It can be a brisk exposure with a very loud noise or less noise but for a prolonged time like in leisure activities and some occupational exposure.[28]

Sorensen showed that the satisfactory music loudness people usually enjoy for entertainment is between 89-93 dB and as the volume increases more, the difference in loudness will not be perceived despite more than two to four-fold increment.[29] Previous research showed that if avoiding loud noise exposure for a significant amount of time is not an option then it is highly recommended to use earplugs and muffs to protect the very sensitive hair cells of the inner ear.[30]

Sound energy is usually absorbed as the number of people increase in a confined space. For that reason, to keep the momentum, the loudness of the music increases much to overcome the absorbed sound energy with increasing numbers of patrons in the room. That explains our finding of increased noise level around midnight comparing it with the 10 pm measurement. Other research has shown that nightclubs and bars have noise well above the permissible level.[26.27] Our research also showed that 41% of bars breached maximum permissible sound exposure at 10 pm and 57% at midnight. This finding showed the need for creating awareness among the society and warrant discussion to be held with the labor union and other stakeholders to have a regular and tight control.

Conclusions

Our study showed that the noise level in most of the bars and discotheque are beyond the maximum recommended exposure level for both the working staff as well as the visiting patrons.We recommend the responsible regulator body to assess such recreational places and act accordingly. And this paper lay the groundwork for future researchers to assess the impact of such noise exposure in bars and nightclubs.

Acknowledgments

We acknowledge the data Collectors and people involved in the interview for their valuable time and participation.

Author's contribution

Both authors were involved from the conception of the research work to the editing of the submitted Manuscript.

Funding: None

Conflict of interest: None

References

1. Phillips SL, Henrich VC, Mace ST. Prevalence of Noise-Induced Hearing Loss in Student Musicians. Int J Audiol 2010; 49(4):309-316.
2. *Samelli. GA. Tinnitus*: *evaluation*, *diagnosis*, and *rehabilitation*: *current approaches*. *Sao Paulo*: *Lovise*; *2004*. p. 17-22

3. Alberti PW, Symons F, Hyde ML. Occupational hearing loss. The significance of asymmetrical hearing thresholds. Acta Otolaryngol. 1979; BN 87:255–263. doi: 10.3109/00016487909126417.
4. Noise and Hearing Loss. In: National Institutes of Health. Consensus Development Conference Statement. Edited by: Services USDoHH. Bethesda, MB: 1990. MB: accessed in September 2020 from: https://consensus.nih.gov/1990/1990noisehearingloss076html.htm
5. Lucio M, et al. Tinnitus and Deafness in the Musicians. Otolaryngol Open Access J 2018;3(3): 000176.
6. Sliwinska-Kowalska M, Davis A. Noise-induced hearing loss. Noise Health 2012;14(61):274-80. doi: 10.4103/1463-1741.104893.
7. Harrison RV. Noise-induced hearing loss in children: A 'less than silent' environmental danger. Paediatr Child Health. 2008;13(5):377-82. doi: 10.1093/pch/13.5.377.
8. Morata TC, Dunn DE, Kretschmer LW, Lemasters GK, Keith RW. Effects of occupational exposures to organic solvents and noise on hearing. Scand J Work Environ Health 1993;19(4):245–54. doi: 10.5271/sjweh.1477
9. Clark WW, Bohne BA. Effects of noise on hearing. JAMA 1999;281(17):1658-9. doi: 10.1001/jama.281.17.1658.
10. Ranga RK, Yadav SPS, Yadav A, Yadav N, Ranga SB Prevalence of occupational noise-induced hearing loss in industrial workers. *Indian J Otol.* 2014; **20**(3): 115.
11. Henderson D, Hamernik RP. Impulse noise: a critical review. J Acoust Soc Am. 1986; 80(2):569–584. doi: 10.1121/1.394052
12. Spoendlin H. Histopathology of noise deafness. J Otolaryngol 1985;14(5):282–6. PMID: 3906151.
13. International Standard, I. S. O. 1999. acoustics: estimation of noise-induced hearing impairment 2013. Accessed in September 2020 from https://www.iso.org/standard/45103.html
14. McBride DI, Williams S. Audiometric notch as a sign of noise-induced hearing loss. Occup Environ Med. 2001; 58(1): 46–51. Doi. 10.1136/oem.58.1.46
15. Kim DK, Park Y, Back SA, et al. Protective effect of unilateral and bilateral earplugs on noise-induced Hearing loss: functional and morphological evaluation in an animal model. Noise Health 2014;16(70):149–56. doi: 10.4103/1463-1741.134915.
16. Reddy RK, Welch D, Thorne P, Ameratunga S. Hearing protection use in manufacturing workers: A qualitative study. Noise Health 2012;14(59):202-9. DOI: 10.4103/1463-1741.99896
17. Groenewold MR, Masterson EA, Themann CL, Davis RR. Do hearing protectors protect hearing? Am J Ind Med 2014;57(9):1001-10. DOI: 10.1002/ajim.22323
18. Eichwald J, Scinicariello F, Telfer JL, Carroll YI. Use of Personal Hearing Protection Devices at Loud Athletic or Entertainment Events Among Adults - the United States, 2018. MMWR Morb Mortal Wkly Rep.;67(41):1151-55. doi: 10.15585/mmwr.mm6741a4. PMID: 30335738; PMCID: PMC6193686.
19. Colon DC, Verdugo-Raab U, Alvarez CP, et al. Early indication of noise-induced hearing loss from PMP use in adolescents: A cross-sectional analysis. Noise Health 2016;18(85):288-96. Doi:10.4103/1463-1741.195798
20. Riga M, Korres G, Balatsouras D, Korres S. Screening protocols for the prevention of occupational noise-induced hearing loss: the role of conventional and extended high-frequency audiometry may vary according to the years of employment. Med Sci Monit 2010; 16(7): CR352-6. doi: 10.12659/msm.880932. PMID: 20581779.
21. Dana Doda. An Assessment of Noise Pollution in Addis Ababa: The Case of Bole Michael Community Area. Presented in partial fulfillment of the requirement for the Degree of Master in Development management. 2017.
22. Kinfe Mesfin, Abdrie Seid Hasen, Mohamed Birhanu. Determination of Noise Pollution Level in Dire-Dawa City, Ethiopia. IJESNR 2018; 8(2): 61-5. DOI: 10.19080/IJESNR.2018.08.555733
23. Mahasha KA, Mohamed Ahmed. Assessing the Noise Levels in Adama City, Ethiopia. Int J Res Appl Sci Eng Technol 2018;6(IV): 4599-4604. DOI: 10.22214/ijraset.2018.4754.

24. Center for Disease prevention and Control. Loud noise can cause hearing loss: How do I prevent hearing loss from loud noise. Accessed in September 2020 from https://www.cdc.gov/nceh/hearing_loss/how_do_i_prevent_hearing_loss.html
25. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to noise 1998. publication no. 98–126. accessed on sept 21,2020 from http://www.cdc.gov/NIOSH/docs/98-126/default,html
26. Ariel Spira-Cohen, Anna Caffarelli, Lawrence Fung. Pilot study of patron sound level exposure in loud restaurants, bars, and clubs in New York City. J Occup Environ Hyg 2017;14(7):494-501. doi: 10.1080/15459624.2017.1296234.
27. Welch D, Fremaux G. Why Do People Like Loud Sound? A Qualitative Study. Int J Environ Res Public Health *2017*;14(8):908. doi:10.3390/ijerph14080908
28. Ward WD, Santi PA, Duvall AJ 3rd, Turner CW. Total energy and critical intensity concepts in noise damage. Ann. Otol. Rhinol. Laryngol 1981;90(6):584-90. doi: 10.1177/000348948109000615. PMID: 7316382.
29. Sorensen R., Beach E., Gilliver M., & Daugaard C. Preferred listening levels – a silent disco study. *Proceedings of the International Symposium on Auditory and Audiological Research 2017*; *6*, 255-262. Accessed in September 2020 from https://proceedings.isaar.eu/index.php/isaarproc/article/view/2017-31
30. Richard N, Noah S. The effectiveness of hearing protection among construction workers. Comparative Study. J Occup Environ Hyg 2005;2(4):227-38. doi: 10.1080/15459620590932154.