RESEARCH ARTICLE

DANGEROUS DECIBELS: RECREATIONAL NOISE EXPOSURE AMONG MEDICAL STUDENTS IN NAIROBI, KENYA

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ABSTRACT

Background: Recreational noise is on the rise and young adults are increasingly exposing themselves to dangerous sound levels from recreational activities. Noise induced hearing loss is permanent. Excessive noise exposure can lead to hearing-related problems such as Noise-Induced Threshold Shifts (NITS), tinnitus, noise sensitivity and eventually Noise-Induced Hearing Loss (NIHL). Hearing is not damaged typically by day to day sounds. However, the possibility for noise induced hearing loss is increased if one engages in loud activities for prolonged periods of time.
Objective: To determine the amount of recreational noise exposure among young adults in medical school using the recreational noise questionnaire.
Design: This was a cross sectional study.
Methods: The study was performed in the ENT Department of KNH among young adults in medical school aged 18-35 years. Subjects were recruited via convenient sampling after which they completed a recreational hearing habits questionnaire. Data analysis was conducted using SPSS version 18. During the initial descriptive analysis each variable in the database was analysed, in turn. For continuous data including age, mean and standard deviation was calculated. Frequency distribution was used to summarize the categorical variables
Results: One hundred and sixty three subjects were recruited and evaluated with a mean age of 24.6 years and a M:F sex ratio of 1.04:1. The average total sum of spent hours per week for all activities was 5.6 hours (range, 1.8-12.1 hours) with a median of 5.1 hours. The average total sum of spent hours per year was 293.2 hours (range, 93.6 – 629.2 hours) with a median of 265 hours. The highest weekly noise exposure in equivalent SPLs was found in going to night clubs (82.9 dBA). The median weekly equivalent noise exposure for all activities was 67.7 dBA. Fifteen point three percent of subjects exceeded the Environmental Protection Agency limit of 75 dBA.
Conclusion: A large number (15.3%) of youth expose themselves to harmful noise above the recommended exposure level of 75dBA. The median weekly noise exposure levels are high but not over the limit.

Key words: Recreational noise, Noise-induced hearing loss, Youth hearing impairment, Concerts, Nightclubs, Music festivals and personal listening devices

INTRODUCTION

The rise of non-occupational hearing loss is of concern[1] and has been documented to have tripled in the last 20 years[2]. Excessive noise exposure can lead to hearing-related problems such as Noise-Induced Threshold Shifts (NITS), tinnitus, noise sensitivity and eventually Noise-Induced Hearing Loss (NIHL). Hearing is not damaged typically by day to day sounds. However, the possibility for noise induced hearing loss is increased if one engages in loud activities for prolonged periods of time[3,4].

Whereas, there are no studies on the effects of recreational noise exposure in Kenya, investigators from other parts of the world have not only reported the prevalence of recreational noise exposure in some countries but also shown a trend towards increasing NIHL from this exposure[3,5-8].

Public legislation and Recommended Exposure Levels (RELs) have been established by regulators to reduce both occupational and non-occupational noise. Occupational exposure to noise is well documented[9]. The European Union Directive 2003/10/EC[10] set exposure limit values and exposure action values of $L_{EX,8h}$ 80 dB(A) and 85 dB(A) respectively.

Today, the environmental noise standards are primarily two. The US Environmental Protection Agency (EPA) established a limit of Lex, 8hr 75 dBA[11]. Twenty-five years later, the World Health Organization (WHO) adopted Community Noise Guidelines and recommended exposure limit of Lex, 8hr 75 dBA[12].

It is imperative to note that the Kenyan law, both NEMA[13] and the Factories Act[14] sets a noise ceiling of between 25 dB(A) and 55 dB(A) for non-occupational noise. Sounds at those levels are not harmful to the ear. These restrictions are not in keeping with either EPA[11] or WHO standards[9] or other scientific literature[15,16] and require to be realigned.

The ubiquity of music exposure makes hearing health care professionals' worried[1]. There is heterogeneity in the global literature of recreational noise because some literature looked at solitary sources of noise exposure whereas others looked at noise in the context of multiple recreational activities. Various sources of sound produce different sound levels.

Going to night clubs regularly can be a cause of high noise exposure according to William's *et al*[4]. The mean noise levels were 97.9 dBA with a range of 90-105dB. The second part of the study found that 60% of the recommended noise exposure levels in an entire lifetime is acquired during the short 10-year period where revelling is a regular activity. This underlined the notion that going to a night club provides a significant source of noise for young people.

Henderson *et al*[1] reported a 75% increase in popularity of personal listening devices between 1990 and 2005. Torre[17] reported 90% of youth between 18-30 years used personal listening devices. Swanepoel and colleagues[18] performed sound level measurements in a stadium and described a range between 113dB and 130dB.

Vogel *et al*[19] using questionnaires on self-reported music exposure from variable sources reported that 54.4% of participants exceeded the noise limit. Keppler *et al*[20] who also using a questionnaire concerning recreational noise exposures, placed the subjects into 3 self-reported groups of low, intermediate and high noise exposure. The average weekly noise exposure was 70.09 dBA. One third of the subjects were exposed to noise higher than 75dBA.

Jokitullpo *et al*[21] demonstrated that 50% of Finnish youth had an average weekly noise exposure of 80dBA with 27% of Finnish conscripts being exposed to noise levels over the 85 dBA risk limit.

Young adults are immersed in social activities that may be dangerous to their hearing and wellbeing. The term "ipod oblivion" is used to describe the inattentiveness of those engrossed with PLDs[22]. This may lead to risk or injury because of lack of awareness and an enabling attitude towards noise and hearing loss. This is clear when a survey showed 45% of adolescents did not know there was a program that could limit the noise output on their PLDs. Despite the awareness, most adolescents indicated they would not utilize such technology[22].

These findings therefore support the notion that cumulative exposure to combined sources of non-occupational noise is hazardous.

The objective of the study was to determine the amount of recreational noise exposure among young adults in medical school using the Recreational Noise Questionnaire.

MATERIALS AND METHODS

This was a cross sectional study, conducted at Kenyatta National Hospital Ear Nose and Throat outpatient clinic. The target population were students between the ages of 18-35 years recruited from University of Nairobi, School of Medicine via consecutive sampling. The sample size was 163. Approval was granted by the KNH – UON Ethics and Research Committee, P671/11/2017.

Data collection was done by the principle investigator using a standardized structured questionnaire (recreational habits questionnaire) to document bio data and recreational hearing habits.

The recreational habits questionnaire was based on various studies[20,21,23,24], regarding recreational noise exposure. It included questions on exposure to noise, frequency of exposure, subjective loudness of exposure and use of hearing protection devices during exposure. The sources of recreational noise exposure were evaluated in time spent per week or month, the total time of exposure (in years), and subjective estimation of loudness. The scale of loudness referred to the following sound levels:

(i) A normal conversation, (60 dB)
(ii) A loud conversation, (70 dB)
(iii) If one must shout over 1 m, (80 dB)
(iv) If one must shout over a near distance, (90 dB)
(iv) Where communication is impossible (100dB)

This self-estimated loudness corresponded to A-weighted equivalent sound pressure levels (SPLs) ranging from 60 dBA to 100 dBA for ratings 1 to 5, respectively.

The weekly equivalent noise exposure per activity was calculated as;

$L_{Aeq,w} = L_{Aeq} + 10x\log_{10}(T_w/T_0)$, where;

L_{Aeq} = the A-weighted equivalent SPLs from 60 dBA to 100 dBA,

T_w = the time spent per week in h, and

T_0 = the 40-h reference of a workweek.

Accordingly, the lifetime equivalent noise exposure per activity was computed as

$L_{Aeq,l} = L_{Aeq,w} + 10x\log_{10}(T_y)$, where;

T_y = the time of exposure in years.

The weekly and lifetime equivalent noise exposures for all activities ($L_{Aeq,w\,all}$ and $L_{Aeq,l\,all}$) were determined by calculating the logarithm of the average $L_{Aeq,w}$ and $L_{Aeq,l}$ in Pa, respectively. These calculations were adopted from Jokitulppo.[21] Subjects were divided into 3 groups. This was based on the quartiles of the $L_{Aeq,w\,all}$ and $L_{Aeq,l\,all}$. The subjects with low, intermediate and

high recreational noise exposure were represented by the lower quartile, the interquartile range and the upper quartile.

Data analysis was conducted using SPSS version 18. During the initial descriptive analysis each variable in the database was analysed, in turn. For continuous data including age, mean and standard deviation was calculated. Frequency distribution was used to summarize the categorical variables (e.g hearing loss). A cut off value of 0.05 was used to determine statistical significance.

RESULTS

The study population consisted of 163 subjects ranging from 22-29 years with a mean age of 24.6 years (SD 1.1). There was an almost equal representation with a sex ratio of M:F 1.01:1

Table 1: Recreational noise characteristics

Activity	Percentage of subjects (%)	Laeq,w (dBA)	Laeq, l (dBA)	Time spent Per week (hours)	Per year (hours)
Watch TV	84	61.7	70.8	9.0	468.0
Listen to music via headphones	82	55.3	66.5	10.7	556.4
Go to the movie theatre	80	66.2	73.8	5.9	306.8
Listen to music via speakers	77	68.0	74.4	12.1	629.2
Go to night clubs	41	82.9	88.2	5.3	275.6
Exercise to music	38	62.9	65.7	4.4	228.8
Play videogames	29	61.5	67.8	7.9	410.8
Attend musical concerts	28	71.4	76.0	2.3	145.6
Attend or participate in indoor sports events	20	59.5	64.6	5.1	265.2
Practice a musical instrument	15	63.1	68.6	3.6	187.2
Use of tools	5	63.0	68.9	1.8	93.6
Play with fireworks	4	71.3	76.9	2.4	124.8
Play in a band	4	63.6	71.6	2.3	119.6

The results support the fact that a high percentage of young adults in this study engaged in recreational activities. The most commonly engaged activities among the subjects were watching TV (84%), listening to music via headphones (82%) and going to the movie theatre (80%). However, none of the individual activities was above the noise threshold. The activities with the most spent hours per week were 12.1 hours at night clubs, 10.7 hours listening to music via headphones and 9 hours watching TV. The average total sum of spent hours per week for all activities was 5.6 hours (range, 1.8-12.1 hours) with a median of 5.1 hours. The average total sum of spent hours per year was 293.2 hours (range, 93.6 – 629.2 hours) with a median of 265 hours.

The only activity that crossed the threshold of the Laeq,w of 75 dBA was going to night clubs at 82.9 dBA among 41% of responders. Playing with fireworks and attending music concerts were the next activities with high noise exposures of Laeq,w of 71.2 dBA and 71.4 dBA respectively. However, playing with fireworks had a very low engagement levels of 4% and less than a third of subjects attended music concerts. The average for the total weekly noise exposure was 65.41 dBA (range, 55.3-82.9 dBA). The average for the total lifetime noise exposure was 71.83 dBA (range, 63.2-88.2 dBA).

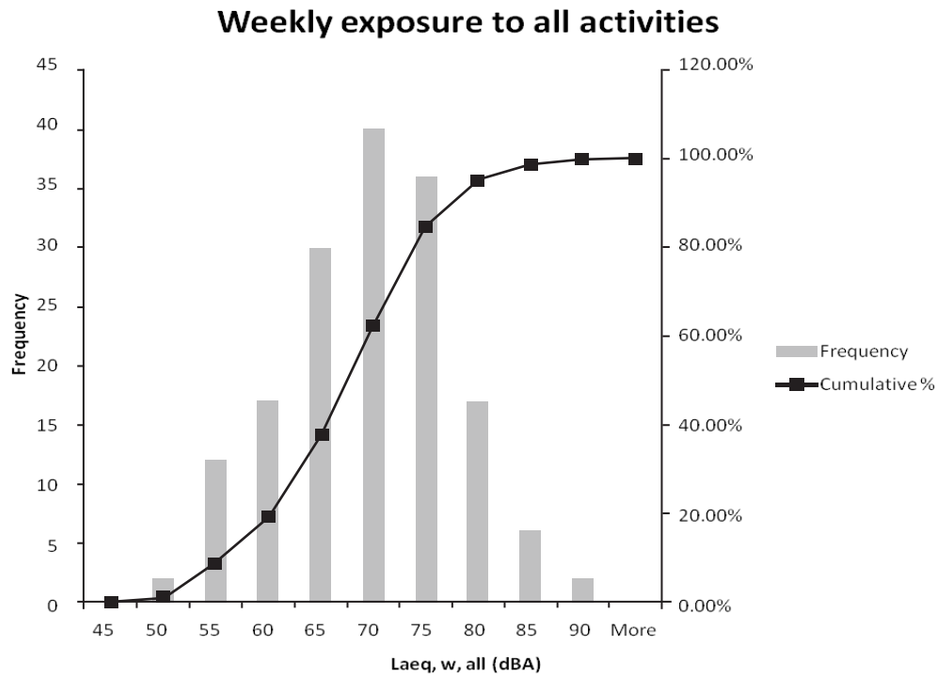


Figure 1: Figure demonstrating weekly exposure to all activities

Altogether, 15.3% of subjects were exposed weekly to noise levels above the 75 dBA risk limit set by the EPA. Only 4.9% of subjects exceeded the minimum action value of 80 dBA set by the European Union Directive 2003/10/EC (2003). Using the least stringent criteria, the maximum allowable limit of the European Union Directive 2003/10/EC (2003), a paltry 1.2 % exceeded the 85 dBA limit.

This highlights the issue that plagues global research of noise exposure; different regulatory agencies in different jurisdictions using different recommended exposure limits.

Table 2: Weekly noise exposure to all activities

Group	Noise exposure	Distribution	Laeq, w, all (dBA)
Group 1	Low	Lowest quartile (n=41)	46.7-61.1
Group 2	Intermediate	Inter-quartile range (n=81)	61.2-73.1
Group 3	High	Highest quartile (n=41)	73.1-89.2
		Median (standard deviation)	67.7 (8.3)
		Range	46.7-89.2

For the weekly noise exposure to all activities the lowest 25% ranged between 46.7-61.1dBA, the intermediate 50% between 61.2-73.1dBA and the highest 25% ranged between 73.1-89.2dBA.

The median weekly noise exposure for all activities was 67.7 dB (SD 8.3 dBA) with a range of 46.7- 89.2 dBA. The median noise exposure was below the recommended exposure levels. This demonstrates most young people are not exposed to harmful noise levels. However, there is a small minority at risk.

DISCUSSION

This is the first report of the prevalence of recreational noise in young adults in Kenya. These results suggest that young adults are being exposed to hazardous levels of noise.

A large number (15.3%) of youth expose themselves to harmful noise above the recommended exposure level of 75 dBA. Studies elsewhere showed a prevalence of 11%-50%[21,20]. In the other studies, participants attended night clubs, pop concerts and indoor sports events almost thrice as much as the subjects in this study. This may be due to the higher variety of leisure activities available in European countries. The prevalence in this study of noise exposure among young adults is crucial because these young adults have not yet been exposed to occupational noise nor have they undergone the steady auditory degeneration of increasing age. Furthermore, the prevalence of recreational noise is on the increase[1,2].

Even though the 5 activities most engaged in brought the most concern in the media and modern discourse, none of these recreational activities were above the EPA limit of 75 dBA and as such none are sources of hazardous noise. Despite the worrisome popularity of PLDs, there are other sources of recreational noise which require our attention. This compares similarly with other studies that showed use of PLDs doesn't give the highest noise exposure[20,25].

Going to a night club was a common recreational activity among the subjects (41% attendance) with a mean of 5.3 hours per week which agreed with Jokitulppo *et al*[21] and Williams *et al*[4]. Characteristically, going to a night club produced the highest sound, 82 dBA, which is above the maximum weekly noise exposure permitted. The high noise output in night clubs is in keeping with other studies that looked at noise and going to night clubs[3,4,23,24]. Regularly going to a night club is an element of youth culture which embraces high noise exposure. A continuous period of regular club attendance with exposure to noise hazards contributes to a significant portion of lifetime exposure to noise. The EUs Scientific Committee on Emerging and Newly Identified Health Risks estimated that 5-10% who listen to music at sound levels exceeding 89 dBA for 1 hour per week are at risk of permanent hearing loss after 5 years or more[16].

CONCLUSION

Young people willingly engage in hazardous noise activities and hence are most vulnerable to recreational and leisure noise-induced hearing loss. According to this study, the prevalence of 15.3% of subjects were exposed weekly to hazardous recreational noise levels. The median weekly noise exposure levels are high but not over the limit.

STUDY LIMITATIONS

This was a cross sectional study and may have led to a recall bias or errors in the calculation of a-weighted weekly and lifetime equivalent noise exposure values. The noise levels vary during the activities, unlike the steady noise in occupational settings.

RECOMMENDATIONS

Noise management is crucial. Night club goers require to be informed and warned about the dangers they are exposing themselves to and the auditory effects of their activities. The development of standards or guidelines to regulate recreational noise exposure should be revised. Hearing loss is cumulative hence a long-term prospective study following a cohort and measuring their occupational and recreational noise exposure would provide the natural history of NIHL secondary to recreational noise exposure. A follow up study to identify the effects of non-occupational noise exposure on young adults is required.

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REFERENCES

1. Henderson E, Testa MA, Hartnick C. Prevalence of noise-induced hearing-threshold shifts and hearing loss among US youths. *Pediatrics*. 2011; **127**(1):e39-46.
2. Smith PA, Davis A, Ferguson M, *et al*. The prevalence and type of social noise exposure in young adults in England. *Noise & Health*. 2000; **2**(6):41.
3. Beach E, Williams W, Gilliver M. Estimating young Australian adults' risk of hearing damage from selected leisure activities. *Ear & Hearing*. 2013; **34**(1):75-82.
4. Williams W, Beach EF, Gilliver M. Clubbing: The cumulative effect of noise exposure from attendance at dance clubs and night clubs on whole-of-life noise exposure. *Noise & Health*. 2010; **12**(48):155.
5. Shargorodsky J, Curhan SG, Curhan GC, *et al*. Change in prevalence of hearing loss in US adolescents. *J Amer Med Ass*. 2010; **304**(7):772-778.
6. Gitau JM, Mwikali JM, Bett KW, *et al.* Noise induced hearing loss among textile industry workers in Eldoret, Kenya. Faculty of Health Sciences, Moi University. 1998 July. pp1-16
7. Chauhan DM. Noise induced hearing loss in a steel rolling mill company in Nairobi, Kenya. Faculty of Health Sciences, University of Nairobi. MMed thesis. 2015.
8. Anino JO, Afullo A, Otieno F. Occupational noise-induced hearing loss among workers at Jomo Kenyatta International Airport, Nairobi. *East Afr Med J.* 2010; **87**(2):49-57.
9. Lie A, Skogstad M, Johannessen HA, *et al*. Occupational noise exposure and hearing: a systematic review. *Intern Arch Occup Environ Health*. 2016; **89**(3):351-372.
10. Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) (Seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)
11. United States. Office of Noise Abatement. Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety. for sale by the Supt. of Docs., US Govt. Print. Off.; 1974.

12. Berglund B, Lindvall T, Schwela DH, World Health Organization. Guidelines for community noise. 1999. World Health Organisation. available at http://whqlibdoc. who. int/hq/1999/a68672. pdf. 2014 May.
13. Legal notice no. 61. The Environmental Management and Coordination (Noise And Excessive Vibration Pollution) (Control) Regulations, 2009.
14. Legal Notice 25 by the Ministry of Labour and Human Resource Development, The factories and other places of work Act, Cap 514.
15. Exposure, ON, 1998. Revised criteria, 1998. National Institute for Occupational Safety and Health, http://www. cdc. gov/niosh/98-126. html.
16. Scientific Committee on Emerging and Newly Identified Health Risks - SCENIHR, Potential health risks of exposure to noise from personal music players and mobile phones including a music playing function (2008). Available from: http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_018.pdf
17. Torre III P. Young adults' use and output level settings of personal music systems. *Ear & Hearing*. 2008; **29**(5):791-799.
18. Swanepoel DW, Hall III JW, Koekemoer D. Vuvuzela: good for your team, bad for your ears. *South Afr Med J*. 2010; **100**(2):99-100.
19. Vogel I, Verschuure H, van der Ploeg CP, *et al*. Estimating adolescent risk for hearing loss based on data from a large school-based survey. *Amer J Publ Health*. 2010; **100**(6):1095-100.
20. Keppler H, Dhooge I, Vinck B. Hearing in young adults. Part II: The effects of recreational noise exposure. *Noise & Health*. 2015; **17**(78):245.
21. Jokitulppo J, Toivonen M, Björk E. Estimated leisure-time noise exposure, hearing thresholds, and hearing symptoms of Finnish conscripts. *Military Medicine*. 2006; **171**(2):112.
22. Ivory R, Kane R, Diaz RC. Noise-induced hearing loss: a recreational noise perspective. *Current Opinion Otolaryngol Head Neck Surg*. 2014; **22**(5):394-398.
23. Keppler H, Dhooge I, Vinck B. Hearing in young adults. Part I: The effects of attitudes and beliefs toward noise, hearing loss, and hearing protector devices. *Noise & Health.* 2015; **17**(78):237.
24. Degeest S, Clays E, Corthals P, *et al*. Epidemiology and risk factors for leisure noise-induced hearing damage in Flemish young adults. *Noise & Health*. 2017; **19**(86):10.
25. Zocoli AM, Morata TC, Marques JM, Corteletti LJ. Brazilian young adults and noise: attitudes, habits, and audiological characteristics. *Intern J Audiology*. 2009; **48**(10):692-699.