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Effect of Environmental Noise Exposure on the Aural Health of Adolescent Males of Metropolitan Area

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Abstract

Environmental noise is considered as most unwanted outdoor noise emitted from different neighborhood sources, excluding the noise of industrial regions. In metropolitan areas, as a part of technological and infrastructural development, noise emission from transportation and other sources is increasing and imposing significant influence on our living environment which may affect the citizen, including children, being recurrently exposed to it. In this context, the present work was conducted to evaluate the effect of noise exposure, if any, on aural health status of Bengalee adolescent males residing and attending school in metropolitan area. 44 individuals (age 16-18 years) residing in and around Kolkata was selected as Exposed Group (EG) and 52 males of similar age, residing in the relatively tranquil and quiet rural area constituted the Control Group (CG). The audiometric evaluation was conducted on each study participants in the comparatively quiet room and the degree of hearing impairment was calculated. The noise survey was conducted in concerned school premises. The results indicate that EG males had significant ($P < 0.05$) bilateral hearing impairment at speech frequency compared to CG individuals. From the present work it may be mentioned that adolescent males residing in the metropolitan area are suffering from hearing impairment.

Keywords: community noise, children, audiometric evaluation, degree of hearing impairment

Introduction

India is the habitat of second largest population of world and the population with specific lifestyle habits is strongly associated with various communicable and non-communicable diseases (Remais *et al.*, 2013). Physical environmental factors and their changed mode of action make the environment worse for livelihood. Health complications, such as respiratory tract infections, asthma, tonsillitis, sinusitis and

otitis media, are very common among children and sometimes these diseases contribute to massive health complication (Hussain *et al.,* 2011, Kumar *et al*., 2015). Hearing loss enforced by elevated noise levels is a major irreversible community health hazard and also it considered as most crucial silent epidemic in several developed and developing countries (Abuosi *et al*., 2016). This millennium gained the speed by its improvised transportation networks and achieved the goal of smartest communication rapidly. In busy metropolitan areas, community noise derived from transportation system and non-industrial sources contribute influence on human health, both auditory and non-auditory (Kumar *et al*., 2015). The frequently generated loud traffic noise with maximum intensity around urban busy road intersections is closely linked to metabolic disorders (Belojevic *et al*., 2008, Christensen *et al*., 2016, Munzel *et al.,* 2014). Elevated transportation noise influences the stress level such as alterations in cortisol level (Bigerta *et al.,* 2005, Bluhm *et al.,* 2007). School is an important socio environmental institution essential for the educational and intellectual development of the children (Evans *et al*., 2007) whereas adverse conditions (such as loud noise level) of school considered as one of the main risk factors effecting children communicative competence, literacy development and psycho-cognitive skills (Clark *et al.,* 2007, Theunissen *et al.,* 2011, Kumar *et al.,* 2015). Background noise induced annoyance is a major health issue, encompasses broad area of psychological feelings of displeasure and it increases with raising the physical variables of sound level (frequency, temporal variability and tonality) (Nassiri *et al.,* 2014, Seabi J. 2013).Any kind of hearing loss is undesirable for any individuals and it is significantly affects the social communication of individual (Malakootian *et al.,* 2012).The amplified impulsive noise imposes the greatest risk for considerable auditory difficulties and children are not out of it. In countries like Nigeria and Kenya, the prevalence of hearing impairment is significantly higher among child population (Kae *et al.,* 2009).In this context, the present work was conducted to evaluate the effect of noise, if any, on aural health status of school going adolescent children residing and attending school in metropolitan area.

Methodology

The present work was carried out on 44 Bengalee adolescent males (16-18 years) permanently residing and attending school in metropolitan area in and around

Kolkata, constituting Exposed Group (EG) and 52 adolescent males of comparable age, permanently residing in relatively calm and quiet rural area of West Bengal, constituting the Control Group (CG). Individuals with any prior history of congenital aural difficulties and suffering from otitis media with effusion (self-reported) were excluded. After obtaining necessary approval from the educational institutions, the names of agreeable study participants were enlisted and the entire procedural requirements were explained to them and their parents elaborately. Information about their age (years), socio-economic status and background information were recorded in pre-designed study format. Stature (to the closest 0.1cm), using stadiometer and body weight (to the closest 0.1 kg) (Ong, 2010), of the student participants were measured being in light clothing and without shoes. Body Mass Index (BMI) was calculated. Pre exercise systolic and diastolic blood pressure (mm Hg) and heart rate (beats.min^{-1}) were recorded using an automated digital blood pressure monitor (Paunovic *et al.,* 2011, Clark *et al*., 2011) (Aydin *et al.,* 2007, Pradeepa *et al*., 2015). Information (self-reported) about any difficulty in speech understanding (DSU) (Mayo *et al*., 1997; Thompson *et al*., 2018), ringing in the ear (RE) was collected and recorded (Acharya *et al*., 2013). The ambient noise level of the audiometric evaluation room and in different part of the concerned school premises was checked and recorded periodically by using standardized sound level meter (Acharya *et al.,* 2013, Nassiri *et al*., 2014). Pure tone audiometric assessment (Sarafraz *et al*., 2009) was conducted on each individual at a time for both left and right ears independently using the air conduction mode, with a calibrated portable audiometer for obtaining the hearing sensitivity threshold at different frequencies (0.25-8 kHz) (Muller *et al.,* 2012) On obtaining the hearing sensitivity thresholds, the bilateral hearing impairment status and the degree of bilateral hearing impairment level was calculated as per WHO and ASHA recommendation (Kochhar *et al*., 2007, Ketabi *et al*., 2010, Harrison *et al.,* 2016, Hall *et al*., 2016). Obtained data were tabulated and used for further statistical analysis using SPSS with significance levels were set at $P < 0.05$.

Results

In the present work, participants were school going young adolescent males residing in metropolitan and rural region of West Bengal; all of them were Bengalee Hindu and were from middle class stratum of the society. All EG and CG males were of

comparable age and socio-economic status. But the mean Body Height (BH), BMI, pre exercise systolic blood pressure, diastolic blood pressure and heart rate of the EG males is significantly different ($P<0.05$) compared to their CG counterparts.

Variables	**EG**	**CG**
Residence	Metropolitan area in and around Kolkata	Rural area of Hooghly, West Bengal
Religion	Hinduism	Hinduism
Nature of educational institution being attended	Public funded	Public funded
Socio - economic status	Middle	Middle
Sample Size (n)	44	52
Age (years)^	15.36±0.74	15.63±0.71

Table 1: Basic characteristics of the study participants

Variables	**EG**	**CG**
Body Weight (kg)^	50.5±12.72	50.0±6.85
Body Height (cm)*	158.3±9.32	164.1 ±7.60
Body Mass Index (BMI)*	20.04± 3.95	18.5±2.30
$BP_{Systolic}$ (mm Hg)*	118.3±15.29	114.9±8.50
$BP_{Diastolic}$ (mm Hg)	71.1±12.55	60.3±6.46
Heart $Rate_{Pre\ Activity}$ ($beats.min^{-1}$)*	82.8±13.11	79.3±10.92

*$P<0.05$, ^ns

Table 2: Physical and physiological profile of EG and CG individuals

After recording of basic physical and physiological parameters, audiometric evaluation was carried out and data obtained are represented below. In the present study, ambient noise levels in the school premises during school hours were recorded periodically and the range has been found to be 73-87dBA.

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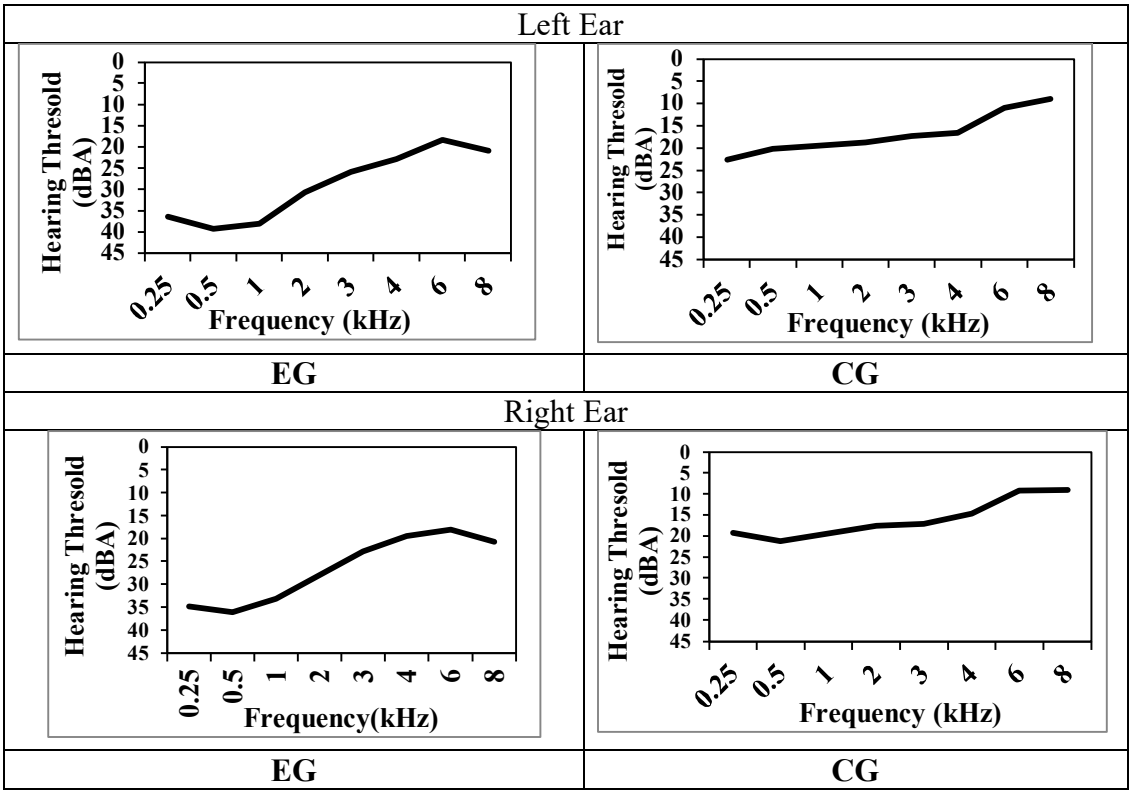

Fig.1 Average hearing threshold in dB (A) at different frequencies (0.25-8kHz) for left and right ears, of EG and CG males

In figure 1, the graphical presentation of audiometric status has been presented. Significant changes in hearing threshold shift at speech frequency and higher frequency were observed among EG males than CG counterparts.

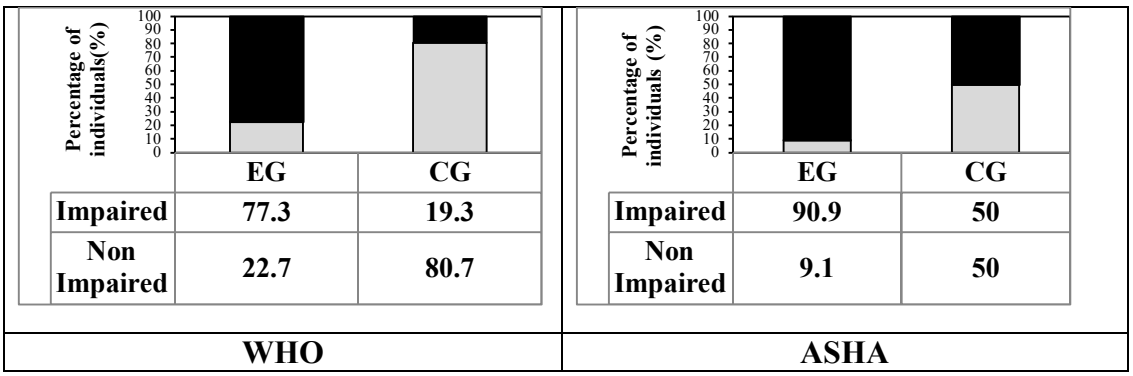

Fig. 2 Comparison between EG and CG males in respect of bilateral hearing impairment status as per WHO and ASHA hearing impairment classification.

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In figure 2, Comparison of bilateral hearing impairment status as per WHO and ASHA hearing impairment classification between EG and CG has been presented. In the present study among 44 EG males, 34 (77.3%) males were observed with bilateral hearing impairment as per WHO hearing impairment criterion (Kochar *et al*., 2007, Tekriwal *et al*., 2011) and as per ASHA hearing impairment criterion (Harrison *et al.,* 2016) 40 (90.9%) males were observed with bilateral hearing impairment. On the other hand, in case of CG males as per both WHO and ASHA hearing impairment criterion, lees number of males has been observed with bilateral hearing impairment.

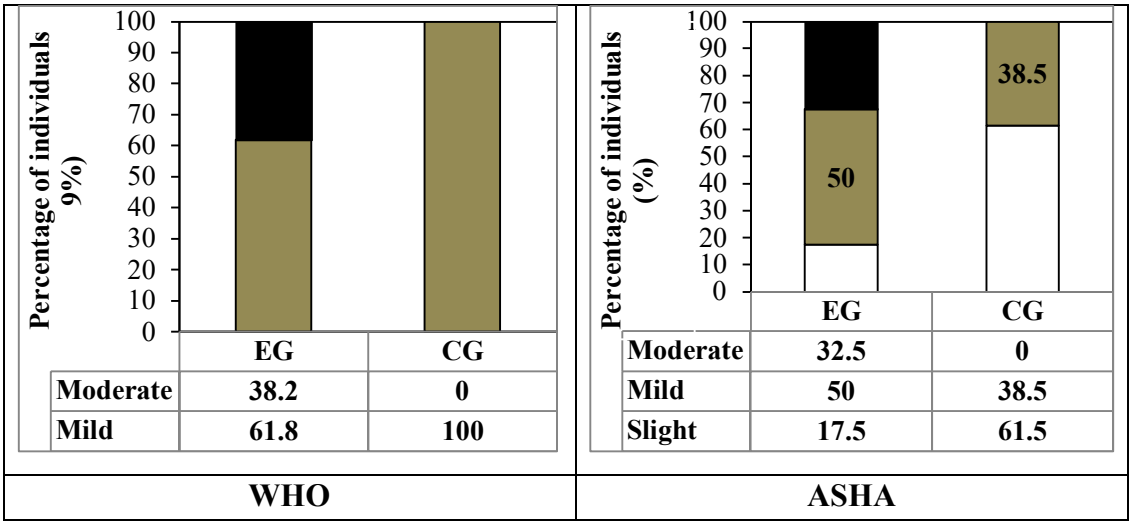

Fig.3 Degree of hearing impairment status of EG and CG impaired males as per WHO and ASHA hearing impairment classification.

In figure 3, the degree of bilateral hearing impairment status as per WHO and ASHA hearing impairment classification was compared between EG and CG males. In the present study as per WHO hearing impairment classification among 34 EG impaired males, 21 (61.8%) were identified with 'mild' degree of hearing impairment and 13 (38.2%) were identified with 'moderate' degree of hearing impairment. As per more stricter ASHA hearing impairment criterion (Hall *et al*., 2016), among 40 impaired males, 7 (17.5) were observed with 'slight' degree of hearing impairment and 20(50%) were observed with 'mild' degree of hearing impairment and remaining 13 (32.5%) individuals was observed with 'moderate' degree of hearing impairment. On the other hand, among 10 CG impaired males, all of them were observed with 'mild'

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degree of hearing impairment as per WHO hearing impairment criterion; whereas as per more stricter ASHA classification, out of 26 (50%) CG impaired males, 16 (61.5%) were observed with 'slight' and rest of 10 (38.5%) were observed with 'mild' degree of hearing impairment.

Difficulty in speech understanding (DSU), an essential indicator for the development of school going children, was also assessed and presented in fig 4 (a). Ringing in the ears (RE), which may be caused due to regular exposure to high noise level, is also taken into consideration for the present study and a comparison between EG and CG males has been presented in fig 4(b)

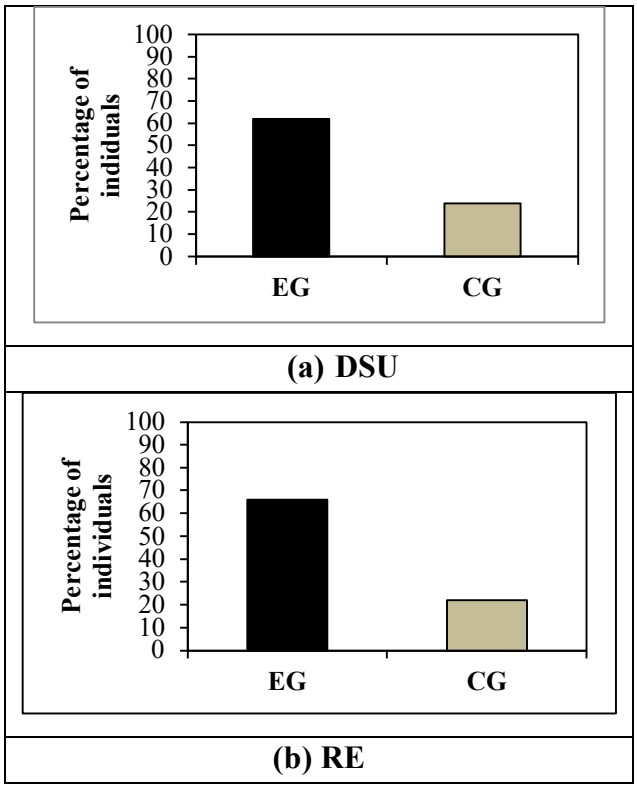

Fig 4. Comparison between EG and CG males in respect of (a) DSU and (b) RE

It has been found from fig 4 (a) and (b) that higher percentage of EG males were suffered from DSU and RE (as reported) compared to their CG counterparts.

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Discussion

Auditory health issues including loss of hearing sensitivity is the most irreversible health problem of our society and its spreading frequently by intensifying severity. Many occupational environments have been identified as more noisy and the exposures may lead to noise induced hearing loss among the exposed individuals (Ketabi *et al*., 2010, Chatterjee *et al*., 2015). In earlier study, it has been reported that individuals occupationally exposed to noise are suffering from hearing impairment with highest degree of severity (Chatterjee *et al*., 2014, Chatterjee *et al*., 2015). Life style factors of social environment has been linked with different non communicable diseases; as per specific references, (Chatterjee *et al*., 2017) it has been found that higher body mass index (Pradeepa *et al.,* 2015), an indicator of overweight and obesity (Banerjee *et al.*, 2014, Mukherjee *et al.,* 2014), is positively associated with high frequency hearing loss among young adults (Chatterjee *et al*., 2014, Christensen, *et al*., 2016). It has been observed in previous studies that ambient sound level in urban areas is significantly high due to exposure of community noise (Malakootian *et al.,* 2012). In the present study, ambient noise levels in the school premises during school hours were recorded periodically and the range has been found to be 73-87dBA which is significantly higher compared to the SPLs of the schools located in rural areas (34-46dBA). The audiometry is an important test which helps to determine the lowest level of signal to which a person can hear, and the previous studies suggested that the development of any kind of permanent threshold shift (PTS) is an indicator of noise-induced hearing loss (NIHL) (Olszewski *et al.,* 2005). As the present work was aimed to evaluate the effect of noise on aural status of the adolescent males, hence audiometric assessment was performed on all EG and CG individuals on both ears separately. It has been observed from the audiogram that EG individuals have significant average hearing threshold shift at speech frequency compared to their CG counterpart, indicating that adolescent individuals exposed to metropolitan environment has been suffering from hearing loss (Fig.1). Comparable trend has been observed in prior study conducted on children residing in the vicinity of busy railway tracks (Chatterjee *et al.*, 2015). According to WHO and ASHA hearing impairment classification, the adolescent male individuals of the present study residing in metropolitan area have significant bilateral hearing impairment at speech frequency than their CG counterpart, not only that it was also observed from the result of the present study that significant number of EG males have ‘mild’ and

'moderate' degree of hearing impairment according to WHO hearing impairment categorization (Tekriwal *et al.,* 2011). Similar trend of result has been found in earlier studies carried out on school going children exposed to community noises (Chatterjee *et al.,* 2016, Chatterjee *et al.,* 2019) (Tharpe, 2008) and in adolescent school going males exposed to railway and aviation noise residing in and around busy municipal areas (Chatterjee *et al*., 2018, Chatterjee *et al*, 2015, Chatterjee *et al*, 2021). In this present work more stricter ASHA classification (Hall *et al*., 2016) was applied to assess the audiometric profile of both EG and CG males in which the hearing impairment threshold level (dBA) is initiated from 17dBA. In consonance with ASHA criterion (Harrison *et al.,* 2016), the result of the present study indicated that both EG and CG individuals are suffering from 'slight' degree of impairment, 'mild' and 'moderate' degree of hearing impairment was significantly observed among EG males than their CG counterparts. The present study is in agreement with earlier study conducted on young adolescent males residing near vicinity of airport (Chatterjee *et al*., 2014, Chatterjee *et al*., 2017). As per earlier study it was suggested that less noise is subjected to less hearing impairment (Mukherjee *et al*., 2014) and in the present study it has been observed that CG males residing in less noisy rural area have better auditory status compared to their age and sex matched EG males. The association between elevated noise exposure and problem in speech understanding was established by immense number of literature and signify DSU as an important indicator for the development of school going children. In the present study, it has been observed that a significantly higher proportion of EG males reported they were having the problem of DSU compared to their CG counterparts (Fig. 4.a). The trends of result are in tune with an earlier study carried out on adolescent children suffered from speech recognition and sentence intelligibility in noisy environment (Peng *et al.,* 2016). Ringing in the ears (RE), another problem, which may be caused due to exposure to elevated noise for a long period, is also taken into consideration for the present study and a comparison between both EG and CG males (Fig. 4.b). In the present work significantly higher percentage of EG males were suffered from RE (as reported) compared to their CG counterparts. The results are in agreement with a previous study carried out to observe the understanding levels and characteristics of tinnitus of school children in Turkey (Aksoy *et al.,* 2007). In different studies it has been reported that higher level of noise is found to be detrimental and causes harmful effect on auditory and non-auditory status of individuals (Chatterjee *et al*, 2022,

Stansfeld *et al.,* 2000). The present study also revealed that noisy school environment leads to decrease in hearing sensitivity and loss of hearing sensitivity at young age may sometimes leads to negative influence psycho social wellbeing and educational performance of individuals (Elmenhorst *et al*., 2014).

Conclusion

It may be concluded from the present study that adolescent males residing in noisy metropolitan areas were suffered from significant hearing impairment with allied health issues compared to individuals residing in less noisy rural areas.

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