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Impact of Occupational Noise on Hearing Threshold Profile Among Male Industrial Workers

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Abstract: With respect to population growth, there will inevitably be an increasing need for improvements in technology, which has led to greater energy efficiency, higher labour efficiency, continuous production methods and operating flexibility; in addition to these factors, mechanisation has also advanced rapidly. It has been also been reported that the introduction of louder machines with the process of industrialisation has made noise a major occupational and environmental hazard. Against this backdrop, a study has been conducted to assess the impact of occupational noise, if any, on the hearing status of human resources occupationally engaged in the industry. A total of 57 male volunteers, aged between 25 and 39 years, working at least for a period of 5 years, constituted the exposed group. A total of 36 individuals of comparable age working in administrative office constituted the control group. Hearing impairment was calculated at speech frequency, up to 4 kHz and up to 6 kHz. The degree of hearing impairment was also calculated. From the present study, it may be concluded that the hearing ability of the human resources, engaged in different sections of the industry, is significantly impaired compared to their age matched counterparts.

Key words: Audiometric test, degree of hearing impairment, industry, speech frequency.

Introduction

The progress of a country, to a great extent, is measured by its industrial development. Industries are important for developing a country's economic status as well as providing occupations to the majority of the country's population, like India (Sensogut, 2007). In addition to this, the poor environment prevalent in the industries also imposes several adverse effects on the health of the workers, particularly in developing countries (Chatterjee et al., 2020a, 2020b, 2019a, 2019b, 2015a). Various works carried out in order to expand the productivity in the industry have pointed out the necessity to utilise larger machinery in parallel with the improvements in technology. Workplace health hazards generally differ from those found in the general environment. In industries, human resources are often exposed in confined spaces and exposure levels to workplace hazards are often much higher than in the general environment. The major workplace hazards include mechanical hazards (unshielded machinery, unsafe structures in the workplace and dangerous tools). The hazard due to noise is one of the most important occupational risk factors both in industry and transportation (Santos and Júnior, 2009). Noise is a major environmental concern in many industries, such as the steel industry, automobile industry, dyeing industry, agriculture, electronics, pharmaceutics, military, construction work, cement

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factories and transportation (Henderson and Saunders, 1998). Exposure to continuous noise above 85 dBA may lead to hearing loss. This loss is different for person to person and depends on the frequency of the noise and the duration of exposure (Melamed et al., 2001). Exposure to noise for a considerable period of time may lead to an occupational disease such as noise-induced hearing loss (NIHL), which is bilateral and symmetrical. It usually affects the higher frequencies (3k, 4k or 6k Hz) and then spreads to the lower frequencies (0.5 kHz, 1 kHz or 2 kHz). Other health effects due to the noise are lack of concentration, irritation, fatigue, headache, sleep disturbances, etc. The major industries responsible for exposing workers to excessive and hazardous noise levels are textile, printing, saw mills, mining (Nandi and Dhatrak, 2008). NIHL is typically present with gradual bilateral, high frequency and sensorineural hearing loss. Hearing loss resulting from excessive exposure to noise is bilateral and both ears are affected. Noise-induced hearing loss may also be prominent among workers in heavy industry (Boateng and Amedofu, 2004). The provision of the health and safety to the workforce against work-related hazards is imperative and underpins the healthy and vibrant economy of any country. Against this backdrop, the present study has been undertaken to assess the impact of noise on hearing threshold profiles at different frequencies among the male human resources occupationally engaged in the organised sector.

Materials and Methods

Initially, the authorities of the organised sector were approached for permission to carry out the study on their working human resources at mutually convenient dates. On obtaining necessary permission the study was conducted on human resources in the age range 25-39 years.

Inclusion Criteria

A total of 57 male human resources working in different sections of the organised sector for at least a period of five years constituted the exposed group (EG). A total of 36 human resources of comparable age range, working in administrative offices of these organisations were randomly chosen to constitute the control group (CG).

Exclusion Criteria

Individuals with congenital hearing problems and those suffering from apparent tympanic membrane rupture, such as presence of pus or infection in the ear, middle ear disease user of an ototoxic drug, including any systemic disease such as diabetes mellitus, hypertension and previous history of head trauma (self-reported) were excluded from the study purview.

Basic Information

Information about the age (year) and working experience (year) of the study participant was recorded in a pre-designed schedule.

Physical and Physiological Parameters

Stature (cm) using anthropometric measurement set with an accuracy of 0.1 cm, body weight (BW) (kg) using a pre-calibrated weighing scale with an accuracy of 0.1 kg, with individuals in light clothing and without shoes, were measured. Body mass index (BMI) (kg. m^{-2}) was calculated from the measured stature and body weight data. The systolic blood pressure (SBP) (mm Hg) and diastolic blood pressure (DBP) (mm Hg) of the participants were recorded in a sitting position using an automated blood pressure heart rate monitor.

Audiometric Test

Audiometric test was carried out with a portable audiometer for obtaining the hearing threshold at different frequencies (0.25 kHz-8 kHz). The audiometric assessment was carried out on each individual simultaneously for both the ears separately using the air conduction mode in pure tone. An audiometric test was performed before the beginning of the work shift to avoid the effect of a temporary threshold shift. The back ground sound level in the audiometric room was periodically checked. Hearing impairment in the individuals was calculated at speech frequency (Tekriwal et al., 2011) and higher frequencies (Ketabi and Barkhordari, 2010; Nandi and Dhatrak, 2008). Obtained data were tabulated and used for further statistical analysis with a chosen level of significance of 0.05.

Statistical Analysis

Standard descriptive statistics (mean ± standard deviation) and Chi-square test were performed with a chosen level of significance of 0.05.

Results

The basic profile of the participants of the present study has been presented in Table 1. EG and CG do not differ significantly in respect of their mean age (years) and working experience (years).

Table 1: Basic profile of study participants

Variables	*EG*	*CG*
Sample Size	57	36
Age^ (year)	35.0 ± 2.77	33.5 ± 8.09
Work Experience (year)	10.1 ± 2.77	10.7 ± 1.05

Note. Data presented in AM ± SD, ^ns.

The physical and physiological profile of the study participants has been presented in Table 2.

Table 2: Physical and physiological profile of study participants

Variables	*EG*	*CG*
Stature ^ (cm)	165.6 ± 6.29	166.5 ± 5.35
BW^ (kg)	61.4 ± 7.30	60.1 ± 5.41
BMI^(kg.m^{-2})	22.3 ± 3.67	21.6 ± 2.24
SBP^ (mm Hg)	118.2 ± 5.82	117.4 ± 5.91
DBP^(mm Hg)	77.8 ± 8.86	76.9 ± 6.90

Note. Data presented in AM ± SD, ^ns

A comparison of the average hearing threshold of EG and CG individuals at different frequencies has been presented in Figure 1.

Bilateral hearing impairment status of individuals of EG and CG at speech frequency, up to 4 kHz and upto 6 kHz has been presented in Figure 2.

The degree of bilateral hearing impairment status at speech frequency, at 4 kHz and 6 kHz, as per the WHO hearing impairment guideline of EG and CG individuals has been presented in Figure 3.

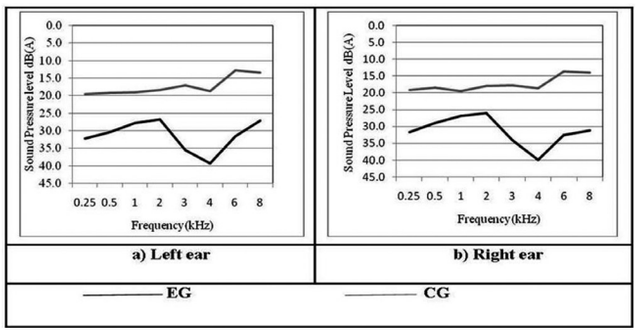

Figure 1: Comparison between EG and CG individuals in respect of average hearing threshold in left (a) and right (b) ears.

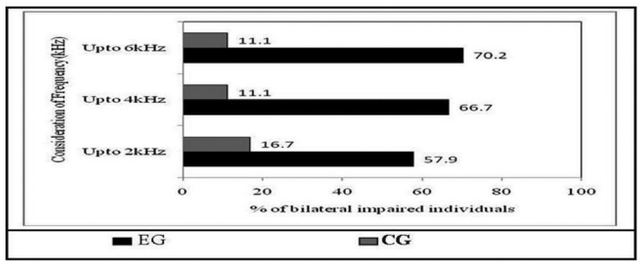

Figure 2: Comparison between EG and CG individuals in respect of bilateral hearing impairment status at speech frequency, upto 4 kHz and upto 6 kHz.

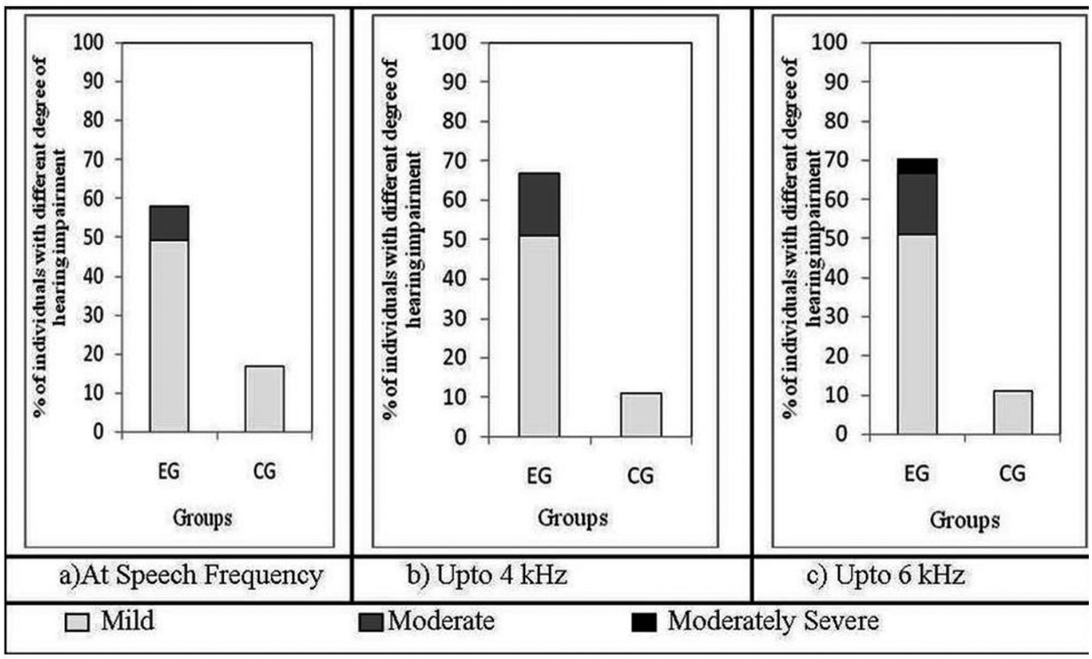

Figure 3: Comparison between EG and CG individuals in respect of degree of bilateral hearing impairment status.

Discussions

As occupational involvement occupies a significant proportion of time of the human resources engaged there, it may have a significant impact on their health-both physical and mental status; earlier studies have found similar kind of results (Banerjee et al., 2014; Bhattacharjee et al., 2014; Chatterjee et al., 2018a, 2015b, 2015c). In the present study, EG and CG individuals do not differ significantly in respect of age (year), stature (cm), body weight (kg) and body mass index ($kg.m^{-2}$). The results of the present study in terms of systolic and diastolic blood pressure (mm Hg) are in agreement with the findings of an earlier study carried out among the human resources occupationally engaged in the transportation sector.

Average hearing thresholds of both EG and CG individuals in different frequencies (0.25 - 8 kHz) have been presented in Figure 1a for the left ear and Figure 1b for the right ear. In EG individuals, the hearing threshold shift is observed to be more in lower frequencies compared to higher frequencies for both left and right ears. A characteristic notch at 4 kHz is observed in the graphical representation which is generated from the average of the individual values obtained in audiometric assessment carried out for the EG individuals (Figures 1 a,b); this observation is similar with the findings of an earlier study carried out among the human resources of electricity transmission company in England and Wales (McBride and Williams, 2001). The findings of the present study regarding audiometric notch are also in tune with the findings of an earlier study (Chatterjee et al., 2015d, 2015e, 2014a, 2014b). It has been also reported in an earlier study that the relationship between audiometric notch and BMI category among the human resources occupationally engaged in organised sector also (Chatterjee et al., 2014a). Repeated noise not only affects the children (Chatterjee et al., 2019c, 2018b, 2016, 2015f, 2014c, Mukherjee et al., 2014) but also affects the concentration of the individuals.

The present study has been carried out on 57 EG and 36 CG individuals. At speech frequency, 57.9% EG individuals and 16.7% CG individuals had a bilateral hearing impairment. When the frequency of up to 4 kHz was taken into consideration, 66.7% of EG individuals and 11.1% CG individuals were found to have a bilateral hearing impairment. When the frequency of up to 6 kHz was taken into consideration, 70.2% of EG individuals and 11.1% of CG individuals were found to have a bilateral hearing impairment (Figure 2). In the present study, a significant difference ($P < 0.01$) has been observed between EG and CG individuals in respect of their impairment status for all three considerations; the findings of the present study regarding the hearing impairment status of the human resources are also in tune with the findings of earlier studies (Harger and Barbosa-Branc, 2004; Harmadji and Kabullah, 2004; Hong, 2005).

As per WHO hearing impairment classification, at speech frequency, bilaterally, 49.1% of EG individuals had 'mild' degree, while 8.8% had 'moderate' degree of hearing impairment, and for CG counterpart, bilaterally, 16.7% individuals had 'mild' degree of hearing impairment. When considered, up to 4 kHz bilaterally, 50.9% of EG individuals had a 'mild' degree and 15.8% had a 'moderate' degree of hearing impairment, and for CG counterparts, 11.1% individuals had a 'mild' degree of hearing impairment. When considered up to 6 kHz, bilaterally, 50.9% of EG individuals had 'mild' degree and 15.8 % of individuals had 'moderate' degree and 3.5% EG individuals had bilaterally 'moderately severe' degree of hearing impairment, and for CG counterparts, 11.1% of individuals had 'mild' degree of hearing impairment (Figure 3a-c). The present study revealed that EG individuals working in different work sections had significantly raised hearing thresholds at lower frequencies and higher frequencies with an increased occurrence of hearing impairment.

Conclusion

From the present study, it may be concluded that the human resources, occupationally engaged in different sections of the organised sector, have significantly more hearing impairment compared to their age-matched counterparts.

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