EnvironmentAsia
The international journal by the Thai Society of Higher Education Institutes on Environment

EnvironmentAsia 11(1) (2018)/217-229
DOI 10.14456/ea.2018.16
ISSN 1906-1714; ONLINE ISSN: 2586-8861

Auditory Profile of Undergraduate University Motorcyclists: Prevalence of Hearing Loss and Hearing Impairment

Anila Ali[1,2,*], Nazri Che Dom[1], Roslinah Mohamad Hussain[1], Subramaniam Karuppannan[3] Mujid Abdullah[1]

[1] *Faculty of Health Sciences, Universiti Teknologi MARA, Selangor Malaysia*
[2] *Balochistan University of Information Technology, Engineering and Management Sciences, Quetta, Pakistan*
[3] *MAHSA University, Selangor, Malaysia*

* Corresponding author: anila928@yahoo.com

Received: October 14, 2017; Accepted: December 2, 2017

Abstract

Motorcycle riders are exposed to excessive turbulent wind noise levels of around 90 dBA at 50km/h and up to 116 dBA at 193 km/h. Prolonged exposure can lead to hearing loss, which has not been investigated among young riders. A cross-sectional study aimed to examine the prevalence of Hearing Loss (HL) and Hearing Impairment (HI) among unscreened 174 undergraduate University motorcyclists. Information regarding respondents and hearing status was acquired through structured questionnaire and Pure-Tone Audiometry (PTA), respectively. Participation was dominated by male riders (66%), age ranging from 19-24 years. The results showed 100% of HL (94.3% bilateral HL, 5.7% non-bilateral HL) and 58.6% of HI (34.5% bilateral HI, 24% non-bilateral HI). Female riders (66.1%) had a slightly higher prevalence of HI than male riders (33.9%). It was found that hearing impairment conditions (normal, bilateral, and non-bilateral HI) was statistically significant with the distance classification (km covered per day), x^2 = (2), 2.10, p = 0.034. The classification of hearing impairment based on World Health Organization, the 57% of the participants had mild HI, 2.3% had moderate HI, 0.6% had severe HI, whereas none were found to be suffering from Profound HI. The prevalence of hearing loss and hearing impairment was significantly higher among young motorcyclists, it emphasis the further in-depth investigation for associated health risks of motorcycling at young age.

Keywords: young motorcyclists; pure tone audiometry (PTA); prevalence of hearing loss; hearing impairment

1. Introduction

Globally, motorcycle usage is growing with an unremitting advancement in transportation and rapid urbanization (Hsu, 2003). Asian countries have an increasing motorization, where motorcycle usage dominants (Manan & Várhelyi, 2012). Most of the Asian cities constitutes an average of seven times more motorcycle (196 per thousand people) than the rest of the world (Senbil et al., 2007). According to 2009 statistics from the Road Transport Department of Malaysia, there were 5% more motorcycles than the passenger cars (HPU, 2009). Despite being a convenient mode of transport, it is also linked to the noise pollution.

Noise impacts dominant on the motorcycle riders, being exposed to excessive turbulent wind flow around the helmet (Mccombe, 2003). Wind noise increases with increasing speeds i.e. 90 dBA at 50km/h up to 116 dBA at 193 km/h (Lower et al., 1996). Open roads, noise exposure ranges from 63 dBA to 90 dBA and up to 105 dBA (Ross, 1989). In general, riders are exposed to noise levels ranging from 90 to 103 dBA (Jordan et al., 2004). Prolonged exposure to excessive noise increases the risk of encountering noise-induced hearing loss (Harvey et al., 2002; Ross, 1989). Noise exposure to approximately 85 dBA, affect temporary dullness of hearing (temporary threshold shift) by recovering within 24 hours of exposure, whereas with chronic exposures, which leads to permanent (permanent threshold shift), degenerate the nerve fibers (Thorne et al., 2008; Dobie, 2001). National Institute for Occupational Safety and Health (NIOSH) recommended that the individual should not be exposed more than 15 minutes at noise exposure of 90–100 dBA without hearing protection equipment (National Institute for Occupational Safety and Health, n.d.).

According to World Health Organization (WHO, 2012) estimation, globally 250 million people are suffering from disabling hearing loss of moderate to profound severity. The primary causes that result in hearing loss into deafness in adults are age, excessive noise, previous illnesses, vascular alterations and ear infections (Gates & Mills, 2005). High prevalence of high-frequency hearing loss has been linked with age and to be more affecting to men than women (Homans et al., 2017). Previous studies have considered age-related reduction in hearing sensitivity as a normal phenomenon. However current literature has suggested health, genetic and environmental variables play a vital role in the sensory changes (Hutchinson et al., 2010). Such confounding variables may include smoking, previous illnesses, alcohol consumption, family history, previous ear discharge, previous head injuries, hypertension, prolonged medication, and obesity (Homans et al., 2017) and changes in the lifestyle (Homans et al., 2017; Kowalska & Davis, 2012; Twardella et al., 2017) such as usage of stereo players, noisy vehicle. Noise induced hearing loss (NIHL) is characterized as permanent sensorineural hearing loss due to intensive, impulsive and continuous prolonged noise exposure (Win et al., 2015; Whittaker et al., 2014) which remains unnoticed unless reached to the damage of sensory hair cells of the inner ear (Shrestha et al., 2011). The audiological profile of NIHL is the presence of sensorineural hearing loss that is most pronounced in the high-frequency region between 3,000 Hz and 6,000 Hz of the audiogram, and the greatest amount of hearing loss is typically around the

4,000-Hz region (i.e., 4,000 Hz dip)(Koh and Takahashi, 2011).

Although some studies have been carried out to assess the significant relationship between hearing loss and professional motorcyclists such as police man (Ross, 1989). traffic police personnel (Gupta et al., 2015; Shrestha et al., 2012) professional riders and courier service officers (Kennedy et al., 2011; Mccombes et al., 1995). But the risk of developing hearing loss due to motorcycling among young riders has not been thoroughly evaluated, and literature reveals an acute shortage of scientific studies on young motorcycle rider's physical and psychological health-related to noise. Therefore, this study aims to investigate the prevalence of hearing loss and hearing impairment with descriptive analysis at various frequencies among young motorcyclists.

2. Materials and Methods

2.1 Subjects

A quantitative cross-sectional survey was carried out at Universiti Teknologi MARA, Puncak Alam campus. The study population comprised of undergraduate students who ride motorcycle as primary means of transportation. Simple random sampling technique was followed to collect samples across different faculties from 1500 motorcyclists (University registration from January 2015-October 2015) aged between 19-24 years. The sample size (SS) selected for the study calculated by the formula (Creative Research Systems, 2012) for infinite sample size with 95% confidence interval.

The structured questionnaire, information-sheet (describing the purpose of the survey) and participation consent form distributed among 350 motorcycle riders. However, only 309 individuals completed the forms while 206 agreed to participate in the expected study. Figure 1 reports consolidated standards of reporting trials (CONSORT) diagram for recruitment of the participant (Whittaker et al., 2014) for the extraction of 174 final samples. Exclusion criteria were: age (less than 19 years and above 25 years), family history of hearing loss, presence of chronic diseases (diabetes mellitus, hypertension), motorcycle driving experience (less than 6 months or occasional riders), part-time job at noisy environments (restaurant, pub, industry, etc.). Study design and procedures approved by the Faculty's Internal ethical community, Universiti Teknologi Mara (600-FSK (PT.5/2)).

2.2 Study instruments

The general and specific details of the participants obtained on a self-reported questionnaire, includes information related to age, gender, semester, distance traveled per day from current residence to university, driving age of riding the motorcycle,usage of helmet and ear defenders (ear plugs, or ear muffins), past/current ear problems (ear discharge, earache, mumps, measles, head injuries, buzzing/ringing in the ear, ENT problems like tonsillitis), hobbies (shooting, hunting, disco, including listening loud music, playing musical instruments, repairing of engines, scuba diving, flying and gliding), smoking habits and long-term usage of drugs like aspirin, streptomycin and quinine.

2.3 Pure-Tone Audiometry

Technologi Mara, Faculty of health sciences, Center for Environmental Health and Safety, Audiometry testing room. Audiometric testing performed in screening sound-proof audiometer booths (FONIX, model and serial no: FA-12, 001288 and 001290 manufactured by ETS-LINDGREN Stationary USA, ISO 389) and TPH-39P earphones with MX-41/AR cushions that are registered and verified by the Department of Occupational Safety and Health, Malaysia. Calibration carried out for audiometry and silent booth after every 12 months and met the requirement of factories and Machinery (Noise Exposure) Regulations 1989. Participants were advised to avoid loud noise exposure at least 14 hours before audiometric test performance and were confirmed prior to the testing.

Pure-tone air conduction of audiometry testing followed the procedure described by British Society of Audiology (Audiology, 2011). Air conduction hearing threshold levels, HTL (with an increment of 5 dBA) obtained at frequencies between 0.5 kHz and 6000 Hz for each ear in a closed room environment with the minimal ambient noise level of 20–25 dBA (Win et al., 2015). Last heard noise was noted at all frequencies as HTL by screening the right ear first.

Audiometric quality control supervised by a senior occupational health specialist. Normal Hearing is categorized as the air-conduction hearing thresholds levels at all test frequencies (0.5 k, 1 k, 2 k and 3 k, 4 k and 6 kHz) less than 25 dBA. Hearing loss calculated as air-conduction hearing threshold levels is greater than equal to 25 dBA at any frequency tested (0.5 k, 1 k, 2 k, 3 k, 4 k and 6 kHz). Hearing impairment is the arithmetic average of the permanent hearing threshold level at 0.5 k, 1 k, 2 k, 3 kHz which is shifted by 25 dBA or more. Severity of hearing loss and hearing impairment classification based on WHO's grading, i.e., normal hearing from 0-25 dBA or less, 26-40 dBA as mild impairment, 41-60 dBA as moderate, 61-80 dBA severe, and > 80 dBA as profound impairment (World Health Organization, 2012).

3. Statistical Analysis

Participant's information data entered on the excel worksheet. Statistical analysis was performed using Statistical Package for Social Sciences, IBM SPSS (Version 22 Inc., Chicago, IL). Traveling distance was classified into three groups based on their kilometers traveled per day from residence to University and was categorized as: Hostel (within University < 8 km/d), suburbs (> 8 < 20 km/d), and other cities (>21 km/d). Descriptive data was obtained through frequency tables, while the relationship between the variables demonstrated by utilizing the cross-tabulations. Confounding factors were extracted (hobbies, smoking, past ear problems) to determine the relationship between hearing impairment with distance traveled per day through Pearson Chi-Square test. The significance level of probability (α) was set as 0.05 for all analysis.

4. Results

Table 1 summarizes the descriptive socio-demographic profile of 174 motorcycle riders with the average hearing threshold level (HTL) of all frequencies (0.5k-6 kHz) for

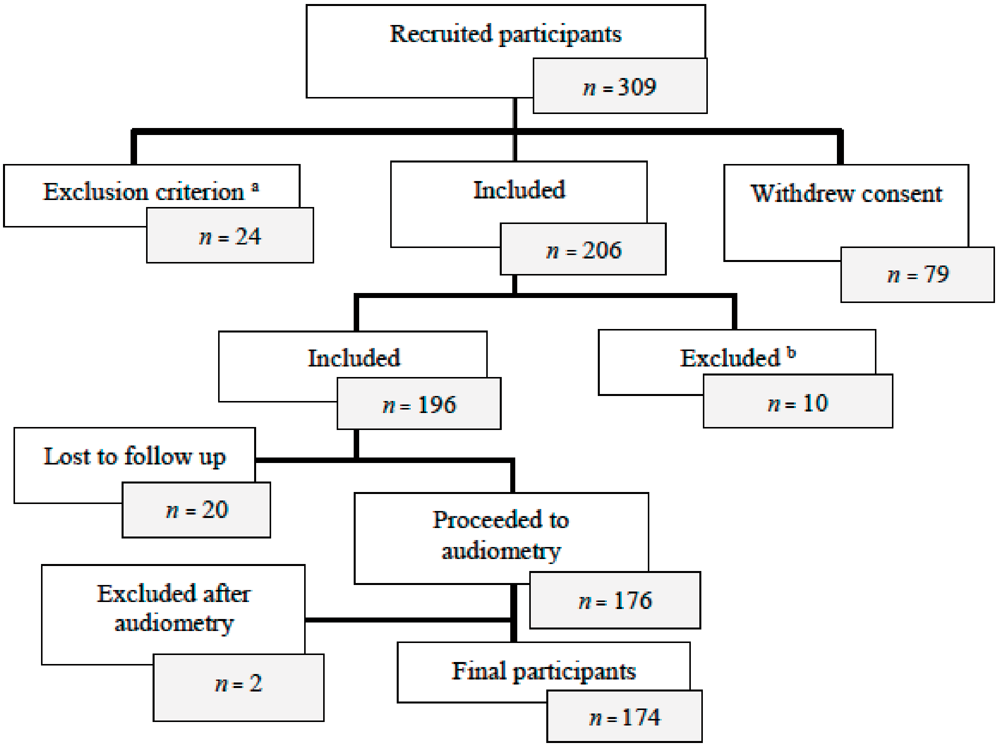

Figure 1. Consolidated standards of reporting trials (CONSORT) diagram of the recruited population (Whittaker et al. 2014) a: age < 19 years, >25 years, chronic diseases (diabetics militias,hypertension), driving experience <6months or occasional riders, part-time job at noisy environment. b: family history of hearing loss

the right and left ear. Male riders dominated with 66% in participation then female riders, while average HTL was higher in females for both ears. The mean age of the participants was 22±1.20, ranged from 19 to 24 years, and average HTL was highest at age 20 and 24. Participants commuting within the university (<8 km/d) constituted 45% of participation, while 42% riders travel from suburban areas and 13% respondents commute from other cities (>21 km/d). Highest average HTL was among participants commuting from other citiesand suburbs. Years of motorcycle driving average age was 5.96±1.17, ranged between 3 to 8 years. Riders with six years of driving exposure dominated (41.4%) followed by seven (20%) and five (17.2%) years. Mean HTL was highest among riders with riding exposure of eight years. There were 12.6% participants with smoking habit with higher average HTL for both ears than nonsmokers (87.4%). Riders with high noise exposure hobbies constituted 36%, whereas, riders with past/current ear problems comprised 14% of participation.

Table 2 illustrates the distribution of motorcycle riders with hearing loss and hearing impairment. Prevalence of hearing loss was 100%, and hearing impairment was 58.6%. Furthermore, the prevalence of non-bilateral and bilateral hearing loss was 5.7% and 94.3%

Table 1. Demographic profile of riders and average hearing threshold levels

Variables	*n*	%	Average hearing threshold level, dB	
			Right ear Mean (*SD*)	Left ear Mean (*SD*)
Gender				
Male	115	66	24,33 (7,15)	23,71 (6,10)
Female	59	34	24,93 (8,80)	26 (8,12)
Age				
19	5	3	21,67 (3,28)	20,67 (2,16)
20	15	8,6	31,22 (16,01)	29,89 (12,41)
21	30	17,2	24,53 (5,95)	25,03 (5,58)
22	72	41,4	23,22 (6,64)	23,71 (6,34)
23	35	20,1	24,14 (5,14)	23,81 (5,31)
24	17	9,7	25,83 (6,90)	24,56 (7,07)
Distance classification (km/day)				
University hostel (≤ 8)	79	45,4	23,22 (6,37)	23,29 (5,29)
Suburbs (> 8 ≤ 20)	73	42	24,58 (8,52)	25,21 (8,49)
Other cities (≥21)	22	12,6	29,1 (7,96)	26,4 (5,65)
Riding experience (years)				
3	5	3	20,5 (4,02)	25 (5,90)
4	15	8,6	25 (5,40)	27,17 (6,91)
5	30	17,2	25,36 (5,85)	25,18 (6,01)
6	72	41,4	24,20 (7,40)	23,25 (5,74)
7	35	20,1	24,14 (10,93)	24,14 (9,04)
8	17	9,7	26,03 (6,83)	26,67 (7,82)
Smoking				
Yes	22	12,6	26,63 (8,78)	25,87 (7,46)
No	152	87,4	24,22 (7,54)	24,29 (6,83)
Hobbies				
Yes	63	36,2	24,08 (5)	23,47 (4,61)
No	111	63,8	24,78 (8,92)	25,06 (7,89)
Past ear problems				
Yes	25	14,4	23,57 (5,09)	23,81 (4,15)
No	149	85,6	24,7 (8,08)	25,6 (7,28)
Total	174	100		

Table 2. Descriptive analysis of hearing loss and hearing impairment

Hearing condition	Right (*n*, ٪)	Left (*n*, ٪)	Non-bilateral (*n*, ٪)	Bilateral (*n*, ٪)
Hearing loss	167 (96)	171 (98٫3)	10 (5٫7)	164 (94٫3)
Hearing Impairment	80 (47٫1)	82 (46)	42 (24)	60 (34٫5)

Table 3. Mean hearing threshold levels at all frequencies (0.56- kHz) for normal and hearing loss

Frequencies (Hz)	Normal		Hearing loss	
Right ear	*n*	**Mean (*SD*)**	*n*	**Mean (*SD*)**
500	15	17٫66 (3٫12)	159	32٫70 (6٫89)
1000	80	18٫12 (2٫8)	94	29٫73 (9٫25)
2000	104	16٫06 (4٫10)	70	28٫93 (6٫19)
3000	105	16٫05 (3٫90)	69	30٫65 (9٫31)
4000	95	15٫26 (4٫46)	79	30٫19 (8٫64)
6000	68	15٫74 (4٫59)	106	33٫02 (10٫90)
Left ear				
500	14	18٫21 (4٫21)	160	33٫25 (6٫22)
1000	77	18٫12 (2٫93)	97	29٫59 (8٫06)
2000	107	16٫77 (3٫71)	67	28٫88 (7٫42)
3000	110	16٫50 (3٫74)	64	30 (7٫66)
4000	99	15٫78 (4٫69)	75	30٫8 (8٫19)
6000	77	15٫84 (4٫26)	97	33٫1 (10٫67)

Table 4. Hearing impairment and hearing loss (WHO classification)

WHO Hearing Impairment, N (%) (Average of 0.5, 1, 2, 4 kHz)					
	Normal (≤ 25 dB)	**Mild (26 – 40 dB)**	**Moderate (41 – 60 dB)**	**Severe (61 – 80 dB)**	**Profound (>80 dB)**
Better ear	114 (65٫5)	58 (33٫3)	1 (0٫6)	1 (0٫6)	0
Worse ear	69 (39٫7)	100 (57٫5)	4 (2٫3)	1 (0٫6)	0
WHO Degree of Hearing Loss, N (%) (Average of 0.5 to 6 kHz)					
	Normal (< 25 dB)	**Mild (25 – 40 dB)**	**Moderate (41 – 60 dB)**	**Severe (61 – 80 dB)**	**Profound (≥80 dB)**
Better ear	113 (64٫9)	50 (28٫7)	1 (0٫6)	1 (0٫6)	0
Worse ear	64 (36٫8)	90 (51٫7)	5 (2٫9)	1 (0٫6)	0
Right ear	90 (51٫7)	70 (40٫2)	3 (1٫7)	1 (0٫6)	0
Left ear	87 (50)	70 (40٫2)	3 (1٫7)	1 (0٫6)	0

Table 5. Relationship between hearing impairment and distance traveled per day

	Hearing impairment conditions, N (٪)				
Distance Classification	Normal	Non-bilateral	Bilateral	Total	Chi-square
≤8	21 (55)	8 (21)	9 (24)	38 (42٫7)	0٫034
>8≤ 20	17 (44)	7 (18)	15 (38)	39 (43٫8)	
≥21	1 (8)	6 (50)	5 (42)	12 (13٫48)	
Total	39 (44)	21 (23٫5)	29 (32٫5)	89 (100)	

respectively, and prevalence of non-bilateral and bilateral hearing impairment was 24% and 34.5% respectively. Prevalence at left ear (98.3%) was higher for hearing loss and right ear (47.1%) for hearing impairment. Amongst gender, 100% of the participants had the prevalence of hearing loss, while the incidence of hearing impairment was higher in female (66.1%) riders than male (33.9%).

Table 3 illustrates the mean hearing threshold level at all frequencies i.e. 0.5k, 1k, 2k, 3k, 4k and 6kHz) for the riders with normal hearing and hearing loss. The highest mean HTL was reported at lowest frequency 0.5 kHz (159 cases) and highest frequency 6 kHz (106 cases) for both ears among hearing loss participants. The mean HTL among hearing loss ranged between 29.59 dB to 33.25 dBA while normal hearing ranged between 15.26 dB -18.21 dBA

Table 4 shows the degree of severity based on WHO's classification of hearing impairment for frequency average of 0.5k, 1k, 2k, and 4k for the better ear (World Health Organization, 2012) and worse ear (Sam et al., 2017) Among 174 riders, 33.9% participants had mild to moderate while 1.2% had moderate to severe hearing impairment in the better ear. For the worse ear, 59.8% riders had mild to moderate while 1.2% had moderate to severe hearing impairment. Degree of hearing loss, based on WHO classification on better ear had 29.3% respondents with mild to moderate and 1.2% moderate to severe hearing loss. Riders hearing loss at worse ear was 55.6% and 3.5% from mild to moderate and moderate to severe respectively. Hearing loss degree of severity was observed to be similar for right and left ear i.e., 41.9% and 2.3% from mild to moderate and moderate to severe respectively.

Relationship between hearing impairment conditions i.e., normal (44%), non-bilateral (23.5), bilateral (32.5%) and distance classification including: < 8 (42.7%), > 8 < 20 (43.8%), >21 (13.48%) were investigated. The relationship examined through Pearson Chi-Square test after excluding the riders (36.3%) with confounding factors i.e. smokers, high noise exposure hobbies and current or past ear problems (see Table 1). Total 89 respondent's (after exclusion) showed statistically significant association between hearing impairment conditions and distance classification, x^2 (2), 2.10, p = 0.034 (Table 5).

5. Discussion

In a review of the previous studies, this is the first study to investigate the auditory effects of motorcycling on young motorcyclists through audiograms in Malaysia. The findings of this study reveal a higher prevalence of hearing loss, and hearing impairment and statistically significant association with the distance traveled per day. Previously the only study based on audiometry assessment on motorcycle hearing impairment was documented by McCombe et al., (1995) on occupational motorcyclists, including police officers, racers and leisure riders, age above 25. Consequently, comparison among other studies is difficult due to scare previous studies, nonetheless according to Ross B.C, motorcycle noise exposure levels and its effects can be comparable to that of industrial settings (< 85dBA), (Ross ,1989). Therefore, variables investigated in this study are associated to occupational population auditory status examined through audiometry testing.

Previous studies concluded a positive association of hearing loss and hearing impairment with age, sex, the past and current exposure time to high noise exposure (Homans et al., 2017; Edward et al., 2016) While in this study hearing loss was equal in both the genders; consistent with industrial based audiometry study (Shrestha et al., 2011). In this study no significant difference was observed between genders, therefore the sexes have equal chances for developing hearing loss under similar noise exposure (Nelson et al., 2005). However, hearing impairment was slightly higher in female riders, which requires to be further investigated As shown in Table 1, age group of the riders ranged from 19 to 24 years, where highest HTLs was observed at 20 and 24 years. Similarly, Musiba (2015) also identified 60% of hearing impairment among the youngest age group (20-29) of miners. In this study, however further in-depth analysis was not conducted due to smaller variations among age group. Motorcyclists riding exposure ranged between 3 to 8 years, mean age 5.96 ± 1.17 years, where highest HTL observed at left ear. Hearing loss and hearing impairment is reported to be associated with increasing exposure to high-intensity noise levels (< 85 dBA) greater than 10 years (Shrestha et al., 2012; Musiba, 2015; Sam et al., 2017) therefore no association was found between riders riding exposure and hearing conditions (results not mentioned).

Among distance classification (Table 1), riders commuting from other cities (≥21 km/d) had highest HTLs for both ears as compared to riders traveling within University premises (≤8 km/d) and suburbs (>8≤21 km/d). Table 5 shows significant association ($p < 0.05$) between hearing impairment and distance classification based on their commuting distance per day, indicating that traveling duration in directly associated with noise exposure and exhibiting incidence of hearing loss and hearing impairment.

In this study, a small proportion (13%) of the riders exhibited smoking habit with higher HTLs than nonsmokers. Previous studies on motorcyclists hearing loss did not attempt to relate smoking with hearing loss and hearing impairment, but according to an industrial study, smokers had a higher prevalence of hearing loss at higher frequencies (Tao et al., 2013) and causes a decline in hearing sensitivity (Cruickshanks et al., 1998). The sample size of smokers for this study was not adequate; therefore, there is a need to explore with the larger dataset, to investigate the smoking and its auditory effects on young riders.

Table 2 shows 100% hearing loss among young riders with 94.3% bilateral HL and 5.7 %

non-bilateral HL. Hearing loss is higher at left ear (98.3%) than right ear (96%) which is consistent with the study on traffic police personnel (Shrestha et al., 2012). Hearing impairment was 58.5% with 34.5% bilateral HI and 24% non-bilateral HI which stands significantly higher in comparison with industrial workers (Sam et al., 2017)

This study revealed a significant proportion of riders suffering from hearing loss and hearing impairment, either one or both ears, even at lower frequencies. The hearing loss at 0.5 kHz was found to be higher in this study (Table 3) which is in consistent with the findings documented by McCombe (2003) on hearing loss of occupational motorcyclists (racers, leisure, police officers), at low frequencies. It was in contrast to other studies on motorcyclists (police officers), which did not reveal any information regarding low-frequency hearing losses (McCombe et al., 1995). According to Harold, motorcyclists experience wind noise resulting from airflow turbulence around their helmet reaching 90 dBA and above, in the frequency band of 500 Hz to 1 kHz, which further tends to increase with increasing speed (Harvey et al., 2002; Kennedy et al., 2011). This wind noise, which predominates in motorcycling experience, damages the lower frequencies hearing of the riders. Even though with the use of ear defenders, low-frequency noise is not attenuated and may adversely affect the lower frequency hearing loss among riders (Harvey et al., 2002). Participants in this study had the habit of wearing helmets (100%) during their motorcycle ride, but none exhibited usage of ear defenders (ear plugs, ear muffins).

It is well-documented that hearing loss first starts at higher frequency and proceed to lower frequencies with continued loud noise exposure (Whittaker et al., 2014; Groenewold et al., 2014). In this study, most of the respondents showed hearing loss at frequencies 4 and 6 kHz (Table 3) as well at 0.5 k and 1kHz, therefore it cannot be concluded if riders experienced noise-induced hearing loss. Further analysis is required for the confirmation of NIHL occurrence among the studied population, including tympanometry, otoscopy, and bone conduction audiometry testing.

Table 4 shows WHO classification of hearing impairment (frequencies averaging of 0.5k, 1k, 2k, and 4kHz) and hearing loss (frequencies averaging from 0.5-6kHz). There were 33.9% and 29.3% riders suffered from slight to moderate hearing impairment and hearing loss at better ear respectively. Motorcyclists might experience some difficulties in hearing conversation (World Health Organization, 2012) which indicates early stages of hearing impairment (Sam et al., 2017).

In comparison to degree of hearing impairment with other studies, Mukesh Edward (2016) reported 56.1 % of the workers ($n = 111$) had a mild hearing impairment at average ambient work-noise of 80.5 dBA. Results reported the lowest age of worker with NIHL was 20 years (Edward et al., 2016). In another study, Musiba (2015) identified 35% mild hearing impairment among mining workers ($n = 246$). The proportion increased with the number of years of noise exposure. The highest number of impairments found among young miners (20-29 years old). Sam (2017), showed 73.3% had Hearing loss, and 23.3% had hearing impairment while 15.1%

mild hearing impairment (worse ear) among small and enterprise workers ($n = 146$). Hearing impairment among young riders in comparison to other studies stands at the highest risk.

The finding from a classic study of McCombe (1995) on motorcyclists hearing loss also provided evidence of both temporary and permanent hearing loss and also emphasized on the regulation of some remedial action. In Malaysia, classification of degree of hearing impairment should be introduced for motorcyclists as suggested by Sam (2017) for occupational workers, to interpret the severity of hearing loss affecting speech understanding and communication.

Moreover, the high-frequency hearing loss has impacts on speech communications, sound localization (Moore, 2016) which further leads to social isolation and difficulties at work, home, and school by directly disturbing the life of disablers and indirectly impacting people around them (Nelson et al., 2005). According to WHO (2013), high frequency of motorcycle fatality involves young rider's aged between 19-29 years. Therefore findings of high prevalence of hearing loss and hearing impairment among young riders should be taken into account for health risk assessments related to injuries for future research through long-term longitudinal cohort studies (Ali et al., 2016), while in a recent study by Ali et al., 2017 showed increased stress response among young motorcyclist. The forum of World Hearing Day by WHO, (Chadha and Cieza, 2017) includes health risks specifically on listening music among youth, however there should awareness programs on increasing trend of motorcycling and its detrimental health effects among youth. Hearing impairment on industrial level reportedly related to safety and health issues and high-risk factor of encountering injuries due to inability to communicate or hear important environmental sounds (Hong et al., 2013). Moreover, listening efforts and noise sensitivity increases with age and tends to be prominent in the fourth decade of life (Degeest et al., 2015). Therefore, this large percentage of hearing impairment among young motorcyclist can render the future workforce, which is likely to be more sensitive to noise with increasing age, needs immediate consideration.

6. Conclusion

Prevalence of hearing loss and hearing impairment found to be higher among young motorcyclists. The significant association between hearing impairment and distance traveled (km/day) identifies the risk associated with noise intensity and exposure due to motorcycling at the young age.

This study provides the baseline for the future investigation to the researchers for studying the auditory effects on the young motorcyclist, particularly in Malaysia. It is necessary to conduct further research to fully examine the other risk factors associated with hearing loss and its degree of future severity in this population and risk of developing NIHL. There is also needed to develop more efficient norms for risk assessment associated with motorcycling noise exposure. Effective preventive measures should be implemented if such findings are confirmed in future by other researchers to safeguard the auditory health of the young riders, both in Malaysia and in other countries with dominating motorcyclist's populations.

Acknowledgment

The study was funded by UiTM Shah Alam, CORE Shah Alam and Faculty of Health Sciences, UiTM Selangor, Puncak Alam Campus (Lestari Grant: 600-RMI/DANA 5/3 LESTARI (3/2015). The respondents were rewarded for their participation in responding to the questionnaires and attending the audiometric assessment.

References

Ali A, Dom NC, Hussain RM, Abdullah M. Effect of motorcycling on salivary noise-induced cortisol among young motorcyclists. *Environment-Behaviour Proceedings Journal.* 2017 Oct 8;2(6).

Ali, A., Karuppannan, S., Hussain, R. M., Rajan, S., Abdullah, M., Ikhwan, R., & Chinna, K. Epidemiological root cause analysis of noise and physio - psycho impacts related to motorcycle road accidents. *Journal of Scientific Research and Development* 2016; 3(5); 150–156.

Audiology, B.S. Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking. Berkshire: British Society of Audiology 2011;1–32.

Chadha, Shelly, Alarcos Cieza. Promoting global action on hearing loss: World hearing day. 2017; 1-3.

Chris Jordan, Oliver Hetherington, Alan Woodside, H.H. Noise induced hearing loss in occupational motorcyclists. *Journal of Environmental Health Research.* 2004;3.

Creative Research Systems. Sample Size Calculator. 2013. Available at: http://wwwsurveysystem.com/sscalc.htm [Accessed May 15, 2015].

Cruickshanks KJ, Klein R, Klein BE, Wiley TL, Nondahl DM, Tweed TS. Cigarette smoking and hearing loss: the epidemiology of hearing loss study. Jama. 1998; 279(21): 1715-9.

Degeest S, Keppler H, Corthals P. The effect of age on listening effort. *Journal of Speech, Language, and Hearing Research.* 2015; 58(5): 1592-600.

Dobie RA. Medical-legal evaluation of hearing loss. Ear and Hearing. 2001;22(6):548..

Edward M, Manohar S, Somayaji G, Kallikkadan HH. Prevalence, awareness, and preventive practices of noise-induced hearing loss in a plywood industry. *Indian Journal of Otology.* 2016; 22(1): 14

Gates GA, Mills JH. Presbycusis. Lancet. 2005; 366: 1111–1120

Groenewold MR, Masterson EA, Themann CL, Davis RR. Do hearing protectors protect hearing?. *American journal of industrial medicine.* 2014; 57(9):1001-10..

Gupta M, Khajuria V, Manhas M, Gupta KL, Singh O. Pattern of Noise Induced Hearing Loss and its Relation with Duration of Exposure in Traffic Police Personnel. *Indian Journal of Community Health.* 2015; 27(2): 276-80.

Harvey HD, Hetherington JO, Woodside A, Jordan C. Noise induced hearing loss in motorcyclists. Publication of: Association for European Transport. 2002.

Homans NC, Metselaar RM, Dingemanse JG, van der Schroeff MP, Brocaar MP, Wieringa MH, de Jong B, Rob J, Hofman A, Goedegebure A. Prevalence of age-related hearing loss, including sex differences, in older adults in a large cohort study. *The Laryngoscope.* 2017; 127(3): 725-30.

Hong O, Kerr MJ, Poling GL, Dhar S. Understanding and preventing noise-induced hearing loss. Disease-a-month. 2013; 59(4): 110-8.

Hsu TP, Sadullah AF, Dao NX. A comparison study on motorcycle traffic development in some Asian countries–case of Taiwan. Malaysia, and Vietnam, Final Report, The Eastern Asia Society for Transportation Studies (EASTS). 2003.

Hutchinson KM, Alessio H, Baiduc RR. Association between cardiovascular health and hearing function: Pure-tone and distortion product otoacoustic emission measures. *American Journal of Audiology.* 2010; 19(1): 26-35.

Kennedy J, Holt N, Carley M, Walker I. Spectral filtering characteristics of a motorcycle helmet. InProceedings of Meetings on Acoustics 161ASA .2011; 12(1): 040001). ASA.

Koh, D. & Takahashi, K.. The textbook of occupational medicine practice 3rd ed., Singapore: World scientific publishing Co. Pvt. Ltd. 2011

Lower MC, Hurst DW, Thomas A. Noise levels and noise reduction under motorcycle helmets. Proceedings-Institute Of Acoustics. 1996;18:979-82.

Manan MM, Várhelyi A. Motorcycle fatalities in Malaysia. IATSS research. 2012; 36(1):30-9.

McCombe AW, Binnington J, Davis A, Spencer H. Hearing loss and motorcyclists. The *Journal of Laryngology & Otology.* 1995;109(7):599-604.

McCombe AW. Hearing loss in motorcyclists: occupational and medicolegal aspects. *Journal of the Royal Society of Medicine.* 2003;96(1):7-9.

Moore BC. A review of the perceptual effects of hearing loss for frequencies above 3 kHz. International journal of audiology. 2016; 55(12): 707-14

Musiba Z. The prevalence of noise-induced hearing loss among Tanzanian miners. *Occupational Medicine.* 2015; 65(5): 386-90.

National Institute for Occupational Safety and Health, Occupational Noise Exposure Revised Criteria 1998.

Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. *American journal of industrial medicine.* 2005; 48(6): 446-58.

Road Traffic Volume Malaysia, HPU. Highway Planning Unit, Ed. Kuala Lumpur, Malaysia: Ministry of Works Malaysia. 2009.

Ross, B.C. Noise exposure of motorcyclists. Ann Occup Hyg. 1988; 33: 123–7.

Sam WY, Anita AR, Hayati KS, Haslinda A, Lim CS. Prevalence of Hearing Loss and Hearing Impairment among Small and Medium Enterprise Workers in Selangor, Malaysia. Sains Malaysiana. 2017; 46(2): 267-74.

Senbil M, Zhang J, Fujiwara A. Motorization in Asia: 14 countries and three metropolitan areas. IATSS research. 2007; 31(1): 46-58.

Shrestha I, Shrestha BL, Pokharel M, Amatya RC, Karki DR. Prevalance of Noise Induced Hearing Loss among Traffic Police Personnel of Kathmandu Metropolitan City. Kathmandu University Medical Journal. 2012; 9(4): 274-8.

Sliwinska-Kowalska M, Davis A. Noise-induced hearing loss. Noise and Health. 2012; 14(61): 274.

Tao L, Davis R, Heyer N, Yang Q, Qiu W, Zhu L, Li N, Zhang H, Zeng L, Zhao Y. Effect of cigarette smoking on noise-induced hearing loss in workers exposed to occupational noise in China. Noise and Health. 2013; 15(62): 67.

Thorne PR, Ameratunga SN, Stewart J, Reid N, Williams W, Purdy SC, Dodd G, Wallaart J. Epidemiology of noise-induced hearing loss in New Zealand. NZ Med J. 2008; 121(1280): 33-44..

Twardella D, Raab U, Perez-Alvarez C, Steffens T, Bolte G, Fromme H. Usage of personal music players in adolescents and its association with noise-induced hearing loss: A cross-sectional analysis of Ohrkan cohort study data. International journal of audiology. 2017; 56(1): 38-45.

Whittaker JD, Robinson T, Acharya A, Singh D, Smith M. Noise-induced hearing loss in small-scale metal industry in Nepal. The Journal of Laryngology & Otology. 2014; 128(10): 871-80.

Win KN, Balalla NB, Lwin MZ, Lai A. Noise-induced hearing loss in the police force. Safety and health at work. 2015; 6(2): 134-8..

World Health Organization, 2012. Facts about deafness. Facts about deafness. Available at:http://www.who.int/pbd/deafness/facts/en/ [Accessed February 23, 2016].