A descriptive cross-sectional study on the prevalence of noise-induced hearing loss among traffic enforcers in selected major roads in Quezon City

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Abstract

Introduction Noise-induced hearing loss (NIHL) attributed to occupational noise exposure is one of the most common causes of permanent hearing impairment. In the Philippines, road traffic remains the biggest source of noise. The authors aimed to determine the prevalence of NIHL among traffic enforcers in Quezon City and quantify their occupational noise exposure levels.

Methods Traffic enforcers were recruited via convenience sampling and screened using a questionnaire and otoscopic examination. Participants underwent pure tone audiometry and those found to have hearing loss were classified as "indicative" or "suspected" NIHL. Audiometric measurements of noise levels in areas where the traffic enforcers were assigned were taken using a calibrated smartphone application.

Results "Indicative of NIHL" was highest in the 41 to 50-year age group and "suspected NIHL" was highest in the 31 to 40-year age group. "Indicative of NIHL" was highest among those working for 1 to 5 and 11 to 15 years in the right ear (25%) and 11 to 15 years in the left ear (30%). "Suspected NIHL" was highest among those working for 6 to 10 years. The average noise levels from the different areas measured at different times ranged from 79.0 to 82.5 dB.

Conclusion "Indicative of NIHL" is more prevalent in the older age group while "suspected NIHL" is more prevalent in the middle age group. The prevalence of "indicative of NIHL" is highest among those in service for 1 to 5 and 11 to 15 years while "suspected NIHL" is highest among those in the service for 6 to 10 years. The average noise level measurements were within the safe values suggested by WHO.

Key words: Occupational noise, noise induced hearing loss, pure tone audiometry

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Noise is defined as any undesired sound affecting people negatively by interfering with daily activities and health.[1] Hearing loss, a more common effect of exposure to excessive noise, is often overlooked since it can occur not only because of a single exposure to an intense sound but also through gradual and prolonged exposure to noise.[2] Noise-induced hearing loss (NIHL) is one of the most common causes of permanent hearing impairment and it has two stages.[3] The first stage - temporary threshold shift (TTS) is a temporary hearing loss wherein hearing ability returns to baseline levels after a period of rest.

When regular exposure to noise happens, however, a destructive change in the hair cells of the cochlea occurs. This next stage of NIHL is called permanent threshold shift (PTS).[4]

A significant number of cases of NIHL is attributed to occupational noise exposure.[5] According to the WHO, exposure to sounds greater than 85 decibels (dB) for eight hours or 100 dB for 15 minutes is considered unsafe.[6] Recent research quantified the noise exposure of traffic enforcers in Metro Manila to levels ranging from 75.0 to 99.3 dB.[7] Traffic enforcers have an increased risk of developing noise-induced hearing loss due to the continuous increase in magnitude and severity of road noise.[8] Moreover, road traffic remains to be the biggest source of noise pollution.[9] Hence, the present study aimed to investigate the effects of this occupational health hazard on traffic enforcers.

The results of this study may serve as a basis to implement policies on regular hearing screening for traffic enforcers. Knowing the prevalence of NIHL provides evidence which may help involved authorities recognize seriousness of the matter. It is also one of the few studies on the prevalence of NIHL among Metropolitan Manila Development Authority (MMDA) traffic enforcers in Quezon City; hence, it may serve as a basis for further research in the Philippines focusing on other factors that may contribute to NIHL, and effects of exposure to excessive sounds on health. Thus, the study aimed to determine the prevalence of noise-induced hearing loss among MMDA traffic enforcers working in selected roads in Quezon City using pure tone audiometry (PTA). Specifically, it aimed to: 1) determine the prevalence of NIHL among MMDA traffic enforcers according to length of service, 2) determine the prevalence of NIHL among MMDA traffic enforcers in different age groups, 3) measure the noise exposure levels to which the MMDA traffic enforcers are exposed to at different times of the day.

Methods

This is a descriptive cross-sectional study that determined the prevalence of noise-induced hearing loss using PTA among MMDA traffic enforcers in selected major roads in Quezon City. The study also involved measuring the noise levels at the major roads and at different shifts.

Included as participants were MMDA traffic enforcers who were 1) 21 to 50 years old, 2) assigned along Aurora Boulevard, EDSA or Quezon Avenue, and 3) exclusively working for the MMDA as a traffic enforcer. A map of the assigned duty stations along the three major roads is provided in Figure 1. Excluded from the study were traffic enforcers who 1) had been previously diagnosed with any hearing impairment based on interview or questionnaire, and/or 2) have a ruptured tympanic membrane. Since the number of MMDA traffic enforcers assigned in these areas was limited, all who were eligible to participate in the study were recruited. All individuals who were eligible and who signed the informed consent were considered as study participants.

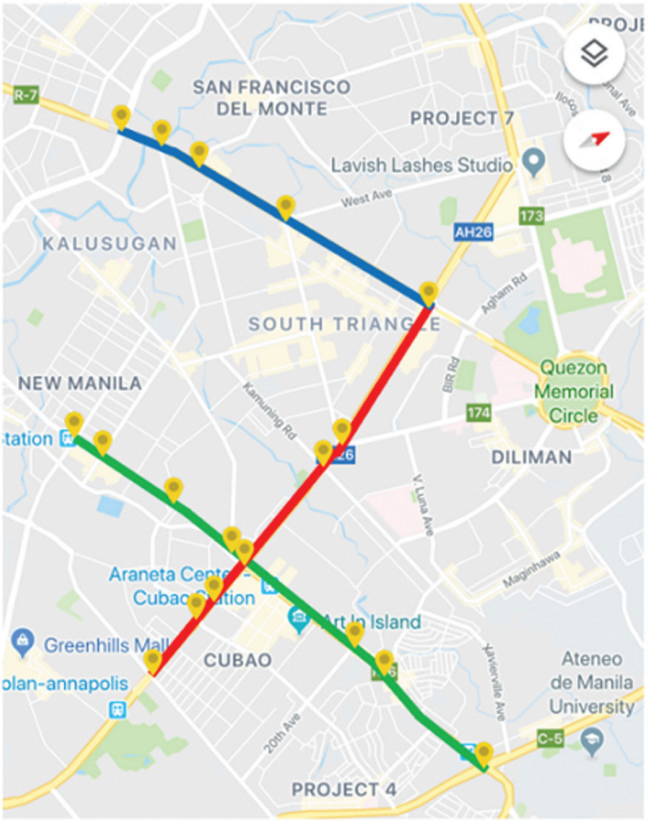

Figure 1. Map of assigned duty areas (yellow pins) of MMDA traffic enforcers along EDSA (red), Quezon Avenue (blue), and Aurora Boulevard (green).

In the computation of the sample size, a prevalence of 12.5% was used as the estimate from a similar study among traffic police in Dhaka, a 95% confidence coefficient and 5% margin of error.[10] This yielded a sample size of 168 MMDA traffic enforcers. However,

the number of enforcers assigned along the three major roads selected in Quezon City was 80. Thus, the sample size was recomputed and corrected for a finite population. The final sample size is 54 and convenience sampling was used.

After obtaining permission to conduct a study from the MMDA administration, traffic enforcers in Quezon City who were available at the MMDA Headquarters were approached by the researchers and invited to participate in the study. A recruitment protocol was followed by the researchers to ensure that important and relevant details about the study were explained to all prospective participants. A questionnaire was used for the initial screening of the subjects to determine if they were eligible. A written consent was obtained from those who were eligible and who agreed to participate. Otoscopic examination was performed on the traffic enforcers to determine the integrity of the tympanic membrane. Prior to data collection proper, the researchers underwent training on otoscopic examination under an ear, nose, throat (ENT) specialist to standardize the manner of performing the otoscopic examination.

Traffic enforcers who agreed to be part of the study and fulfilled the criteria were brought to the American Hearing Center Corporation (AMEARCO) along Aurora Boulevard, Quezon City and underwent a pure tone audiometric test to determine hearing thresholds and screen for hearing loss. Weber test and Rinne test were also done using a 512-Hz tuning fork; the results were noted and interpreted to determine the presence of conductive or sensorineural hearing loss. Hearing thresholds for each ear were measured at 250, 500, 1000, 2000, 4000, and 8000 Hz. Audiogram results were automatically computed and interpreted based on the following scale of hearing impairment: 0-25 dB (normal hearing level), 26-40 dB (mild hearing loss), 41-60 dB (moderate hearing loss), 61-70 dB (moderately severe hearing loss), 71-80 dB (severe hearing loss), and 81-90+ dB (profound hearing loss). Hearing loss was further classified into "indicative for NIHL" and "suspected NIHL". "Indicative for NIHL" was defined as any drop in hearing threshold from 2000 to 4000 Hz regardless of whether there was hearing loss noted at 500, 1000, and 2000 Hz. "Suspected NIHL" was defined as any level of hearing loss that did not present with a drop in hearing threshold from 2000 to 4000 Hz.

Audiometric measurements of the level of noise exposure along intersections where the MMDA traffic enforcers were assigned were done using a smartphone application called dB meter. A high-precision sound level meter (Norsonic Sound Analyser Nor140, Norsonic AS, Norway) was used to calibrate dB meter. Calibration was done in a silent room beside a main road for one minute each for 10 trials. The average of the 10 trials resulted in a 0.5 dB difference between the mobile application dB meter and the Nor140. Subtraction of 0.5 dB for each measurement was done to maintain the appropriate calibration.

Noise level measurements were taken at the following intersections along EDSA: Timog Avenue, Kamuning Road, Aurora Boulevard. Noise levels were measured along Aurora Boulevard at J. Ruiz, Gilmore Avenue, Araneta Cubao, Anonas Road, and Katipunan Avenue. Along Quezon Avenue, noise levels were measured at EDSA, Timog Avenue, Fisher Mall, G. Araneta Avenue, Banawe, and Welcome Rotonda. Measurements were taken at three different shifting periods - in the morning (5:00-7:00 AM), noon (11:00 AM-1:00 PM), and afternoon/night (5:00-7:00 PM) on three weekdays and two weekend days. Readings of ambient noise levels were taken for at least one minute for each area. Measurements for all the five days were averaged per area per shift. These averaged values were further averaged per major road.

Data were encoded in Google Sheets. Mean of data for noise levels taken for five days was calculated per area per shift. These mean values were further averaged per major road. Data for audiometry results were summarized as counts and proportions. Prevalence was computed using the number of MMDA traffic enforcers with "indicative" or "suspected NIHL" on PTA divided by the total number of MMDA traffic enforcers at risk for "indicative" and "suspected NIHL". The distribution of NIHL was described according to age and length of service.

Results

Among the 54 MMDA traffic enforcers tested, 16 (29.6%) were "indicative for NIHL" of the right ear and 20 (27.0%) were "indicative for NIHL" of the left ear. There were 21 (38.9%) participants with "suspected NIHL" in the right ear and 19 (35.2%) in the left ear. Participants who were not suspected to have any NIHL in the right and left ear had prevalence proportions of 31.5% and 27.8%, respectively. The prevalence of NIHL for both ears, is shown in Table 1. The prevalence was highest at 48.2% for" suspected

NIHL" and lowest at 20.3% for "not suspected NIHL". The prevalence of NIHL in the right ear according to age and duration of service is shown in Table 2. With "indicative of NIHL", the prevalence was highest in the 41-50-year age group (75%) and among those who have been in service for 1 to 5 and 11 to 15 years (25.0%). With "suspected NIHL", the prevalence was highest in the 31-40-year age group (61.9%) and those who have been in service for 6 to 10 years (33.3%).

The prevalence of NIHL in the left ear according to age and length of service is shown in Table 3. With "indicative of NIHL", the prevalence was highest in the 41-50-year age group (60%) and those who have been in service for 11 to 15 years (30%). With "suspected NIHL", the prevalence was highest in the 31-40-year age group (57.9%) and those who have been in service for 6 to 10 years (47.3%).

Noise levels ranged from 70 dB to 93 dB. The lowest mean measurement was 79.0 ± 1.0 dB recorded during noon shift along EDSA. The highest mean measurement was 82.5 ± 1.87 dB recorded during morning shift also along EDSA. Quezon Avenue had the highest average noise level at 81.5 ± 3.07 dB and Aurora Boulevard had the lowest average noise level at 80.5 ± 2.97 dB. (Table 4)

Discussion

The prevalence of "indicative for NIHL" is 29.6% for the right ear and 27% for the left ear while "suspected NIHL" had a prevalence of 38.9% for the right ear and 35.2% for left ear. These values are higher than the results of Gupta (22%) and Sharif (24%).[10,11] Win reported a higher prevalence of NIHL (34.2%) among officers in Brunei. Although this is higher than the computed prevalence of "indicative for NIHL" in the present study, it is still less than the prevalence of suspected NIHL among the study participants.[12] All of these support statistical data showing NIHL as a common worldwide problem with at least 10 million adults under age 70 having NIHL in one or both ears.

There were more respondents with "suspected" than "indicative of NIHL". This may be because "suspected NIHL" accounts for hearing loss for all

Table 1. Prevalence of NIHL detected by PTA in right and left ears among 54 traffic enforcers.

NIHL n (%)	Right ear	Left ear	Both ears
Indicative	16 (29.6)	20 (27.0)	17 (31.5)
Suspected	21 (38.9)	19 (35.2)	26 (48.2)
Not suspected	17 (31.5)	15 (27.8)	11 (20.3)

Table 2. Prevalence of noise-induced hearing loss in right ear according to respondents' age and length of service.

Characteristic n (%)	Indicative of NIHL	With suspected NIHL	Without suspected NIHL
Age group (yr)			
21 - 30	0	1 (4.8)	5 (29.4)
31 - 40	4 (25.0)	13 (61.9)	8 (47.1)
41 - 50	12 (75.0)	7 (33.3)	4 (23.5)
Total	16 (100)	21 (100)	17 (100)
Years in service			
<1	0	1 (4.8)	2 (11.7)
1-5	4 (25.0)	5 (23.8)	7 (41.2)
6-10	3 (18.8)	7 (33.3)	5 (29.4)
11-15	4 (25.0)	5 (23.8)	2 (11.8)
16-20	3 (18.8)	2 (9.5)	1 (5.9)
>20	2 (12.5)	1 (4.8)	0
Total	16 (100)	21 (100)	17 (100)

Table 3. Prevalence of noise-induced hearing loss in left ear according to respondents' age and length of service.

Characteristic n (%)	Indicative of NIHL	With suspected NIHL	Without suspected NIHL
Age groups (yr)			
21 - 30	1 (5.0)	1 (5.3)	4 (26.7)
31 - 40	7 (35.0)	11 (57.9)	7 (46.6)
41 - 50	12 (60.0)	7 (36.8)	4 (26.7)
Total	20 (100)	19 (100)	15 (100)
Years in service (yr)			
<1	0	1 (5.3)	2 (13.3)
1-5	5 (25.0)	3 (15.8)	8 (53.4)
6-10	3 (15.0)	9 (47.3)	3 (20.0)
11-15	6 (30.0)	3 (15.8)	2 (13.3)
16-20	5 (25.0)	1 (5.3)	0
>20	1 (5.0)	2 (10.5)	0
Total	20 (100)	19 (100)	15 (100)

Table 4. Average daily noise levels for EDSA, Aurora Boulevard, Quezon Avenue.

Mean ± SD Minimum, maximum value (dB)	EDSA	Aurora Blvd	Quezon Ave
Morning	82.5 ± 1.87 (78, 92)	81.1 ± 2.54 (70, 90)	82.0 ± 1.00 (81, 83)
Noon	79.0 ± 1.00 (78, 81)	80.7 ± 1.78 (75, 85)	81.75 ± 2.75 (79, 87)
Afternoon-evening	81.8 ± 0.75 (75, 81)	79.7 ± 4.60 (77, 79)	80.9 ± 5.46 (75, 93)
Average of 3 periods	81.08 ± 1.21	80.49 ± 2.97	81.54 ± 3.07

frequencies, excluding only results that show a drop in 4000 Hz. McBride concluded that although the notch at 4000 Hz is a well-established clinical sign, it is important to elicit a detailed and accurate history of exposure to noise in order to make a diagnosis of NIHL.[13] They also stated that a notch at 6000 Hz may not be a good marker for high intensity exposure to noise. Conversely, this exclusion is a requirement to be positive for "indicative for NIHL", thus limiting the count.

The factors considered in the study were age and length of exposure to noise. In general, for both ears, those "indicative for NIHL" fell within the 41-50-year age group and have been traffic enforcers for 11-15 years. Similarly, for both ears, those with "suspected NIHL" fell within the 31-40-year age group and have worked for 6-10 years. This bilaterality is expected in NIHL, since most noise exposures affect both ears.[14]

Current data show that there is a consistent increase in the prevalence of "indicative for NIHL" with increasing age. "Suspected NIHL" for participants aged 31 to 40 years is also higher (right ear 61.9%, left ear 57.9%) when compared to participants 21-30 years old (right ear 4.8%, left ear 5.3%). However, the highest prevalence of participants without "suspected NIHL" was also recorded at 31 to 40 years. Moreover, the prevalence of "suspected NIHL" for both ears was lower for traffic enforcers 41 to 50 years old. Toppila found that age was not a primary reason for hearing impairment and that age alone seemed to affect

NIHL to a lesser extent than reported in previous studies.[15] Thus, the finding that the highest prevalence of participants with and without "suspected NIHL" belong to the same age group (31-40 years), and the drop in prevalence of "suspected NIHL" for ages 41 to 50 years may suggest that age is a weak confounding factor for those below 50 years old, when age-related hearing loss or presbycusis is not apparent and not routinely considered.

Based on duration of exposure, the prevalence of subjects with both "indicative" and "suspected NIHL" generally follow the same trends. The higher prevalence among those in service for more than 10 years compared to those who worked for less than 10 years among participants "indicative for NIHL", and the higher prevalence among those who worked for more than five years is consistent with the results of a study among jeepney drivers.[16] These suggest a positive relationship between duration of exposure and prevalence of NIHL. Another study with similar findings reported that 41.1% of traffic policemen with 3 to 5 years' service showed hearing loss compared with 25% among those with 2 to 3 years' service.[17]

The pattern of reaching the highest prevalence at 11 to 15 years ("indicative for NIHL") and 6-10 years ("suspected NIHL") of service and the subsequent declining prevalence thereafter was found to be typical of NIHL according to Mirza.[18] According to them, the rate of hearing loss due to chronic noise exposure increases most rapidly during the first 10 to 15 years of exposure, then decelerates as the hearing threshold increases. This contrasts with age-related loss, which accelerates over time.[18]

This increased prevalence in NIHL for exposures longer than 5-10 years poses risks in the overall health of the MMDA traffic enforcers and other individuals with a similar occupational hazard. A study in India assessed the hearing status of traffic policemen by evaluating their auditory pathway through Brainstem Evoked Response Audiometry (BERA), mid-latency response and slow vertex response. Findings showed that there were increased latencies in waves compared to controls, meaning that chronic exposure of traffic policemen to traffic noise resulted in delayed conduction in the peripheral part of the auditory pathway, more specifically from the auditory nerve to the superior olivary nucleus. No impairment was observed at the level of subcortical, cortical or the association areas.[19] Another study noted that individuals with NIHL may develop hearing loss, concomitant tinnitus, and/or impaired speech discrimination, hypertension, depression, dementia, social isolation, increased risk of accidents, and retrocochlear lesions. Thus, employees with hearing loss should be evaluated to protect them from further damage due to noise as it can impact the worker's communication and safety.

Based on the standards recommended by the WHO, exposure to sounds greater than 85 dB for eight hours or 100 dB for 15 minutes is considered unsafe.[6] The noise exposure levels to which the MMDA traffic enforcers were exposed were measured in the morning, noon, and afternoon and were within 70 to 93 dB. The average values of collected decibel meter readings per shift and per area did not exceed 85 dB but were above 80 dB. Nevertheless, there are individual measurements recorded that went beyond the safe level, with highest at 93 dB, proposing that the risk for NIHL cannot be excluded. Unusually susceptible individuals exposed to noise levels of 80 to 85 dB may develop hearing loss as evidence suggests. Long term exposure above 80 dB increases the risk of developing NIHL.[14]

The 2017 data from MMDA showed that an average of 2.7 million vehicles pass through Metro Manila's roads daily. EDSA was the most congested, with an average daily load of 367,728 vehicles equivalent to 13.62% of vehicles in Metro Manila roads daily. Quezon Avenue was fourth, with 195,335 vehicles (7.23%) daily. These data suggest that MMDA traffic enforcers have an increased frequency and duration of exposure to noise levels greater than 80 dB, despite them not reaching beyond 85 dB.[20] In general, continuous noise exposure over the years is more damaging than interrupted exposure to noise, which permits the ear to have a rest period.[14]

Noise levels to which MMDA traffic enforcers were exposed ranged from 70 to 93 dB. The average values of collected decibel meter readings per shift and per area did not exceed the safe level set by the WHO; however, all average values were above 80 dB. The prevalence for bilateral "indicative NIHL" was highest among the 41-50-year age group and among those who have been in service for 11 to 15 years. For bilateral "suspected NIHL", the prevalence was highest among the 31- 40-year age group and among those who have been in service for 6 to 10 years. Among the three roads, Quezon Avenue had the highest average noise level while Aurora Boulevard had the lowest average noise level.

Future studies can explore the relationship of NIHL to the noise level exposure, duration of service, age and shift schedules. The study is limited to determining the prevalence of noise-induced hearing loss among MMDA traffic enforcers working in selected roads in Quezon City using pure tone audiometry. A study involving several roads and intersections in Metro Manila that will be more representative of the working conditions of the MMDA traffic enforcers may reflect a more accurate estimate of the prevalence of NIHL. Early detection and timely intervention are recommended such as conducting annual audiometry testing to monitor any adverse effects on MMDA traffic enforcers. The use of personal protective equipment such as ear plugs or earmuffs will provide inexpensive and long-term benefits and may be made part of the traffic enforcer's gear. Occupational health authorities can educate the traffic enforcers regarding the potential health impacts of noise. Regular rotation of traffic enforcers to areas with different noise levels may be considered to lessen the risk of noise-induced hearing loss.

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