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Prevalence of Hearing Disorders in Singapore Military Conscripts: A Role for Routine Audiometry Screening?

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ABSTRACT

Aim: To determine the prevalence of hearing disorders in Singapore military conscripts and describe the profile of hearing loss and associated risk factors.

Methods: Population-based descriptive analysis of randomised cohort of 818 Singapore military conscripts presenting for medical examination, using self-administered questionnaire and pure tone audiometry performed for both ears. Main outcome measures are prevalence rate of hearing loss and relative risk of hearing loss by demographic factors and surrogates for noise exposure.

Results: Prevalence of hearing loss was 36.7 per 1,000 (95%CI 24.8, 51.9). Of 30 subjects with hearing loss, 19 (63.3%) had loss at high frequency, 7 (23.3%) at low frequency, and 4 (13.4%) in both ranges. Hearing loss was unilateral in 17 (56.7%) subjects and bilateral in 13 (43.3%). Relative risk of hearing loss did not differ by age group, education level, race or frequency of personal stereo use. Relative risk of hearing loss is higher in subjects with frequent discotheque visits compared to those who never do so (RR = 2.72, 95%CI 1.09, 6.76).

Conclusion: The high prevalence of hearing loss in Singapore military conscripts points to the need for routine audiometry screening prior to enlistment. This will be useful in assigning military vocations, in clinical case management, and for assessing cases of noise-induced hearing loss attributable to military service.

Keywords: Hearing loss, audiogram, military, screening

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INTRODUCTION

There is currently little data on the hearing profile in Singapore youth today. Early reports in the 1970s reported hearing loss in school children and military personnel[1,2], but these findings were based on simplified screening tests for hearing impairment. With rising socioeconomic standards and the post-epidemiologic transition in Singapore, there is a perception that Singapore youth are increasingly exposed to loud noises through use of personal stereo devices, visits to discotheques and computer gaming. It is timely, therefore, for a population-based study on hearing disorders among our youth.

Hearing loss, both congenital and acquired, is important in the military[3-8]. Presently, there is no routine screening programme for pre-existing hearing disorders in Singapore military conscripts, and we are unable to assess the magnitude of the problem. This could lead to conscripts with asymptomatic hearing loss deployed in certain military vocations where they are exposed to high levels of noise, and could result in deterioration of their condition. A baseline audiogram at the time of enlistment will be useful for purposes of assigning military vocations, clinical management of hearing loss, and for assessing any related compensation claims.

This is the first population-based study to determine the prevalence of hearing disorders and their associated risk factors in Singapore young adult males. Findings from this study will be useful to further develop hearing conservation programmes for Singapore youth and in the military.

METHOD

Study population

All Singapore male citizens are conscripted to undergo two to 2.5 years of national service upon reaching a designated age (usually 18 to 23 years) depending on their education status. Prior to their enlistment, they are required to undergo mandatory medical screening at the Medical Classification Centre (MCC), Ministry of Defence, Singapore, when they are between 16 and 23 years old. The population of males presenting at MCC is therefore, representative of the entire cohort of young males in Singapore, with the exception of individuals with significant mental impairment who are exempted from medical examination. Of 17,607 military conscripts presenting

for the first time for medical screening at MCC over a nine-month period from 2000 to 2001, 818 subjects were enlisted into the study using randomly generated numbers. There were no dropouts from the study.

Questionnaire

All subjects were required to complete a self-administered forced-choice questionnaire to obtain their age, race, current education level and information related to noise exposure which included frequency of visits to discotheque, frequency of personal stereo usage and occupational exposure to noise. Frequency of visits to discotheque was categorised into "no previous visits", "once a month", "two to three times per month", "one to two times per week" or "more than twice a week". Personal stereo usage was categorised into "never used", "once a month", "two to three times per month", "one to two times per week", "three to five times per week" or "more than five times per week". Information regarding family history of hearing loss and self-perceived hearing problems were further obtained.

Audiological assessment

Pure tone audiometry was performed for both ears at 0.5, 1, 2, 4, and 8 kHz. All auditory testing was performed in a sound-attenuating booth by a trained technician. Audiometry was done using Madsen Midimate 622 Audiometer calibrated to ISO 389 (1985-E) for measurement for air conduction and ISO 6889 (1987) for bone conduction. In our auditory testing, the signal level decreased in 10decibel (dB) steps until the stimulus is inaudible, and subsequently in an escalating fashion in 5dB steps till a response is obtained[11]. The hearing threshold was recorded to the nearest 5kHz. Threshold value was defined as the lowest signal intensity that the subject detected at least 50% of the time, with a minimum of three tries. Masking was performed if the subject had a threshold value that differed by 40dB or more between both ears. Otoscopic examination of the external acoustic meatus and tympanic membrane was done to exclude any pathology, while tympanogram using Garson Studler Tympanometer 1,738 and bone conduction testing using a bone vibrator were indicated only for subjects with hearing loss.

Definitions

Hearing threshold worse than 25dB in either ear is defined as hearing loss[9-11]. Hearing loss can either be in the low frequency range (0.5 to 2kHz), high frequency range (4 to 8kHz) or both ranges. The magnitude of hearing loss is determined by taking the mean threshold of 0.5, 1 and 2kHz for low frequency hearing loss; the mean threshold of 4 and 8kHz for high frequency hearing loss; and the mean of all frequencies if occurring in both ranges. Severity of hearing loss is further categorised by the extent the hearing threshold exceeded the normal range, and follows the World Health Organisation (WHO) grading: Normal (<25dB); Slight (26 to 40dB); Moderate (41 to 60dB); Severe (61 to 80dB); and Profound (worse than 81dB)[11]. Some authors have defined 0-15dB as normal and 15-25dB as borderline normal[9-10].

Statistical Analysis

Prevalence data and relative risks were presented to the 95% confidence interval (95% CI). For purposes of analysing noise exposure data, frequency of discotheque visits and personal stereo usage were categorised into never exposed, infrequent exposure and frequent exposure. For both personal discotheque visits and personal stereo usage, infrequent exposure was defined as "one to three times per month" and frequent exposure defined as "more than once a week". All statistical analysis was carried out using Intercooled STATA version 6.0. (STATA Corporation College Station, Tex.).

RESULTS

The prevalence of hearing loss of more than 25dB hearing threshold in either one or both ears is 36.7 per 1,000 (95% CI 24.8, 51.9) in young adult Singapore males. All subjects with hearing loss were sensorineural in nature with no cases of conductive hearing loss detected. Of 30 subjects with slight to profound hearing loss, 19 (63.3%) were in the high frequency range, 7 (23.3%) in the low frequency range and 4 (13.4%) in both ranges (see Table I). Seventeen (56.7%) had unilateral slight to severe hearing loss, while 13 (43.3%) had bilateral hearing loss. For subjects with unilateral hearing loss, no difference was found in prevalence between the right and left ears (p=0.68). Only three out of 30 subjects with hearing loss declared hearing difficulty with soft sounds; two had bilateral moderate to severe hearing loss across all frequencies, while one had unilateral profound hearing loss across all frequencies in the right ear. Only two had previously consulted a doctor for this problem.

Prevalence of hearing loss in Singapore young adult males did not differ by age group, race or education level (see Table II). Relative risk (RR) of hearing loss was no different between subjects in the 16 to 19 and 20 to 23 age groups (RR=0.78, 95% CI 0.38, 1.59), and for the majority Chinese race compared to other races (RR=1.59, 95% CI 0.62, 4.06).

Table I. Prevalence of hearing loss by sociodemographic factors among Singapore young adult males (n=818).

		Number of Subjects	Number with Hearing Loss >25dB	Prevalence of Hearing Loss >25dB (per 1,000)	95% CI
Age (years)	16-19	539	18	33.4	19.9, 52.3
	20-23	279	12	46.6	22.4, 73.9
Race	Chinese	621	25	40.2	26.2, 58.9
	Others (Malay, Indian, Eurasian)	197	5	25.3	8.3, 58.2
Current Education Level	'A' Level	215	5	23.2	7.6, 53.4
	Polytechnic	212	6	28.3	10.4, 60.6
	Others ('O' or 'N' Level, Institute of Technical Education)	391	19	48.6	10.6, 60.6
Family History of Hearing Loss	Positive family history	43	2	46.5	5.7, 158.1
	Negative family history	775	28	36.1	24.1, 51.8
Total		818	30	36.7	24.8, 51.9

Table II. Profile of hearing loss in Singapore young adult males (n=818).

Hearing status		Normal	High Frequency	Low Frequency	Both Ranges	Total	Prevalence of Hearing Loss by Severity (per 1,000)
Normal	Normal ≤15 dB	715	0	0	0	715	874.0 95%CI 849.4, 896.0
	Borderline 16-25 dB	0	21	48	4	73	89.2 95%CI 70.6, 110.9
Hearing Loss	Slight 26-40 dB	0	10	6	1	17	20.8 95%CI 12.2,33.1
	Moderate 41-60 dB	0	7	1	1	9	11.0 95%CI 5.0,20.8
	Severe 61-80dB	0	2	0	1	3	3.7 95%CI 0.8,10.7
	Profound ≥81 dB	0	0	0	1	1	1.2 95%CI 0.1,6.8
	Total Hearing Loss >25 dB	0	19	7	4	30	36.7 95%CI 24.8, 51.9
	Prevalence of Hearing Loss by Range (per 1,000)	0	23.2 95%CI 14.0, 36.0	8.6 95%CI 3.4, 17.5	4.9 95%CI 1.2, 12.4	36.7 95%CI 24.8, 51.9	

Relative risks also did not differ for 'A' Level and polytechnic students when compared to those with lower educational attainment (RR=0.48, 95% CI 0.18, 1.26 and RR=0.58, 95% CI 0.24, 1.44 respectively). There is no difference in prevalence rates of hearing loss among those with a family history of hearing loss compared to those without (RR=1.29, 95% CI 0.32, 5.20).

Analysis of noise exposure data showed that relative risks of hearing loss was higher in subjects with frequent discotheque visits compared to those who never do so (RR=2.72, 95% CI 1.09, 6.76). However, no difference was shown for those with infrequent discotheque visits (RR=0.85, 95% CI 0.38, 1.92); frequent personal stereo use (RR=1.08, 95% CI 0.28, 4.08) and infrequent stereo use (RR= 1.27, 95% CI 0.38, 4.20) – see Tables III and IV.

DISCUSSION

The prevalence of hearing loss in our study population was 3.67%. A previous study in Singapore in 1973 reported prevalence of hearing loss in 16% of male school children aged six to eight years[1], but this was based on the inability to hear two out of four frequencies (0.5, 1, 2 and 4kHz) above a 30dB threshold. In another Singapore study involving military personnel, 26.5% of subjects were found to have "hearing impairment"[2], which was defined

Table III. Hearing loss in Singapore young adult males by frequency of discotheque visits.

Hearing status		Never Visit Discotheque (n=442)	Once/month (n= 223)	2-3 times/ month (n=88)	1-2 times/ week (n=43)	>2 times/ week (n=22)	Total (n=818)
Normal	Normal ≤15 dB	392	200	75	33	15	715
	Borderline 15-25 dB	35	17	10	5	6	73
Hearing Loss	Slight 26-40 dB	9	3	2	2	1	17
	Moderate 41-60 dB	3	3	1	2	0	9
	Severe 61-80 dB	2	0	0	1	0	3
	Profound ≥81dB	1	0	0	0	0	1
	Hearing loss	15 (3.4%)	6 (2.7%)	3 (3.4%)	5 (11.6%)	1 (4.5%)	30 (3.7%)
	>25 dB	95% CI 1.9, 5.5	95% CI 1.0, 5.5	95% CI 0.7, 9.6	95% CI 2.6, 22.1	95% CI 0.1, 22.8	95% CI 2.5, 5.2

Table IV. Hearing loss in Singapore young adult males by frequency of stereo use.

Hearing status		Never Use Stereo (n=97)	Once/month (n=105)	2-3 times/ month (n=105)	1-2 times/ week (n=159)	3-5 times/ week (n=171)	>5 times/ week (n=181)	Total (n=818)
Normal	Normal ≤15 dB	85	92	93	138	152	155	715
	Borderline 16-25 dB	9	8	10	15	15	16	73
Hearing Loss	Slight 26-40 dB	1	2	2	3	3	6	17
	Moderate 41-60dB	0	3	0	2	1	3	9
	Severe 61-80	1	0	0	1	0	1	3
	Profound ≥81 dB	1	0	0	0	0	0	1
	Hearing loss	3 (3.1%)	5 (4.7%)	2 (1.9%)	6 (3.8%)	4 (2.3%)	10 (5.5%)	30 (3.7%)
	>25 dB	95%CI 0.6, 8.8	95%CI 1.5, 10.7	95%CI 0.2, 7.60	95%CI 1.4, 8.0	95%CI 0.6, 5.9	95%CI 2.7, 9.9	95%CI 2.5, 5.2

as a hearing threshold exceeding 25dB at 0.5, 1, 2 and 4kHz. There was however, no mention as to whether a case was considered "hearing impaired" based on the mean threshold for the four frequencies, or when the hearing threshold was exceeded at a single frequency.

Recent studies reported a higher prevalence of hearing loss in the United States, with 14.9% of children aged six to 19 having either low or high frequency hearing loss[12]; and in France, with 9% and 15% of youth aged 18 to 24 having hearing loss at 0.5 to 2kHz and 4 to 8kHz respectively[13]. The lower prevalence of hearing loss in our study is attributed to the higher threshold for defining hearing loss. If the case definition of hearing loss is lowered to a hearing threshold exceeding 15dB, prevalence of the condition would be 12.5%, with 40 (4.9%) out of 818 subjects having hearing loss at high frequency, 55 (6.7%) at low frequency and 8 (0.9%) in both ranges. In comparing hearing loss data, the results can vary greatly with the case definition of hearing loss, the age range tested and testing methodology, making direct comparisons difficult. We have adopted a 25dB threshold in our study as most adults can perceive conversation fairly normally until hearing loss exceeds 25dB[9],

beyond which the finding is clinically significant. The threshold for a handicapping hearing loss severe enough to interfere with speech acquisition in a child or effective conversation in an adult is approximately 25 to 30dB[14].

Exposure to excessive noise can cause Noise-induced Threshold Shift (NITS) which can be permanent or temporary[15]. NITS has a distinct audiometric pattern with 3, 4 or 6kHz typically affected at the onset of NITS[16]. Three criteria have to be met before a diagnosis of NITS can be made. First, threshold values at 0.5 and 1kHz are less than 15dB; second, the maximum threshold value at 3, 4 or 6kHz is at least 15dB poorer than the highest threshold value for 0.5 and 1kHz; and third, threshold at 8kHz has to be at least 10dB better than the maximum threshold value for 3, 4 or 6kHz. These three criteria describe a noise notch audiometric pattern[17-19]. Although this pattern could also result from other etiology like hereditary factors, this notched pattern is most commonly associated with exposure to loud noise[17,18].

A diagnosis of NITS was made in 20 (2.4%) out of 818 subjects at 4kHz in either one of both ears. As we did not test hearing threshold at 3 or 6kHz, we were unable to determine its prevalence in our population. Prevalence of as high as 12.5% has been reported in the United States in children six to 19 years[20], and as this can result in difficulty discriminating high frequency sound, may affect oral communication between individuals.

In the 20 subjects found to have NITS, 19 provided a history of frequent noise exposure, with all reporting personal stereo use more than one to two times per week, discotheque visits at least once a month, or both. The relative risk of hearing loss was also found to be 2.72 (95% CI 1.09, 6.76) times higher in subjects who frequent discotheques more than once a week compared to those who never do so. This association between sensorineural hearing loss and noise exposure in discotheques and from personal stereo use has been previously reported[21-25], and point to the need for hearing conservation education for our youth.

CONCLUSION

Military personnel are at risk of exposure to loud noises, especially if they are deployed in artillery, armour or engineer units, or in environments where there is constant exposure to noise, for example, in air bases or ship engine rooms. In fact, military training has been shown to be an important cause of hearing disorders in soldiers[3-8]. This highlights the need for a comprehensive hearing conservation programme in the military, aimed at reducing noise-induced hearing loss. As self-declared history of hearing loss is not a sensitive indicator for performing an audiogram (in our study, only three out of 11 subjects with moderate to severe hearing loss declared having difficulty with hearing soft sounds), this could lead to failure to detect individuals with asymptomatic, but clinically significant hearing loss. A routine audiogram prior to military enlistment would be helpful for the assignment of military personnel to different vocations, in the clinical management of hearing loss, as well as serve as a baseline in assessing cases of noise-induced hearing loss.

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