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Original Article

Noise-Induced Hearing Loss in the Police Force

Kyaw N. Win [1,*], Nayake B.P. Balalla [1], Min Z. Lwin [2], Alice Lai [1]

[1] Occupational Health Division, Department of Health Services, Brunei Darussalam
[2] University of Medicine, Magway, Magwe Division, Myanmar

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ABSTRACT

Background: Noise-induced hearing loss (NIHL) is a major preventable occupational health problem with 250 million people worldwide known to have disabling impairment of moderate to greater severity. The aims of the study are to estimate the prevalence of NIHL in the police force; and study its association with age, sex, duration of service (years), smoking and alcohol habits, use of hearing protective devices, as well as preexisting chronic diseases.

Methods: A cross-sectional study was conducted on 543 police personnel who had undergone periodic medical examination over a 12-month period. The diagnostic criteria for NIHL were (1) history of occupational noise exposure, (2) bilateral hearing loss, (3) hearing loss of $\geq$ 25 dBA at 4,000 Hz in two consecutive audiograms, and (4) no significant medical history affecting hearing. Severity of NIHL was based on the World Health Organization grading.

Results: Males (74.8%) made up the majority of the police force. The mean age for police personnel was 35.55 $\pm$ 9.57 years, and the mean duration of service was 14.75 $\pm$ 9.39 years. Compliance with the usage of hearing protective devices was seen in 64.4%. The prevalence of NIHL in this study population was 34.2%, with a higher prevalence in males (37.7%) than in females (23.9%). The study also showed strong associations between NIHL and male sex (odds ratio, 1.9; $P < 0.05$), and hypertension (odds ratio, 3.3; $P < 0.001$). Overall, 93% were found to have mild NIHL, 3.5% had moderate NIHL, and 3.5% had severe NIHL. No police personnel were found to have profound hearing loss.

Conclusion: The prevalence of NIHL in this study is high compared to other similar studies among police personnel. This study shows that increasing age, male, presence of hypertension, diabetes, and longer duration of service are significant associated factors for NIHL. Preventative strategies include health surveillance, implementation of a hearing conservation program, and legislation.

1. Introduction

Noise-induced hearing loss (NIHL) is sensory neural hearing loss due to exposure to intense impulse or continuous sound. Exposure to noise can be occupational or nonoccupational. The audiologic 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) [1].

The World Health Organization (WHO) currently estimates that 250 million people worldwide have disabling hearing loss of moderate to profound severity [2]. Adult-onset hearing loss ranks 15th in the list of leading causes of Global Burden of Disease and second in the list of leading causes of Years Lived with a Disability [2]. The Norwegian Labour Inspectorate in 2006 reported 3,392 cases of work-related diseases, of which 59% were attributed to NIHL [3].The main causes of hearing loss resulting in deafness in adults in the United States are excessive noise, age, and ear infection [4]. Although occupational hearing loss is a well-recognized occupational condition arising from industries or occupations with exposure to high noise levels (e.g., airline crew), it has not been fully evaluated in occupations where the risk is not so overt, such as the police force. Whereas many studies have been carried out to assess the relationship between hearing loss and gunfire in

* Corresponding author. Occupational Health Division, Block 2G Unit 5-03, Jalan Ong Sum Ping, BSB BA 1311, Brunei Darussalam.
E-mail address: knwin2005@yahoo.com (K.N. Win).

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military personnel [5,6], only a few similar studies have been conducted in police officers. Police officers are potentially exposed to multiple sources of noise, including vehicle horns, gunfire, barking from police dog, and traffic noise [7,8]. Specifically for police motorcyclists, the noise exposure can range from 63 dBA to 90 dBA, and up to 105 dBA in open roads [9].

In Brunei Darussalam, all Royal Brunei Police Force (RBPF) personnel are required to undergo shooting practice at least annually or when required. The provision and compulsory use of hearing protection devices such as ear muffs were introduced into the RBPF since 2005. Prior to this, RBPF personnel with exposure to excessive noise, particularly during shooting practices or in job designations such as police motorcyclists or traffic police, did not have any hearing protection at all. The discovery of a number of NIHL among these police personnel led the study team to carry out a survey to estimate the prevalence of NIHL in this working population, as well as to study the relationship between NIHL and its associated factors. Further to this, we aimed to assist the RBPF force in the implementation of a hearing conservation program as a control measure in the prevention of NIHL. The introduction of such a program could also be adopted in other workplaces with excessive noise levels.

2. Materials and methods

The Occupational Health Division (OHD) conducts periodic medical examinations for RBPF personnel at the nonofficer level 3-yearly when their job contractual agreement is due for expiry. RBPF personnel who are nonofficers hold posts of different ranks such as Police Constable, Lance Corporal, Corporal, Sergeant, Staff Sergeant, and Sergeant Major.

In this study, the medical examinations included obtaining a detailed occupational history, significant medical history, past and current noise exposure history as well as compliance with usage of hearing protective devices, and physical examination, which included body mass index and otoscopic examination for external ear conditions such as ear drum perforation, ear wax impaction, or external ear infections. Other tests such as full blood count, fasting blood sugar, fasting cholesterol, liver function tests, renal function tests, and urine microscopy as well as audiometry test, were also carried out to complete the medical examination. The audiometry test was conducted at least 16 hours after the last noise exposure to exclude temporary threshold shift, a condition where there is temporary hearing loss after noise exposure.

Audiometric testing at the OHD is conducted using a screening audiometer (model AS 208) manufactured by Interacoustic A/S (Assens, Denmark). This is usually carried out by doing air conduction test at frequencies of 500 Hz, 1,000 Hz, 2,000 Hz, 3,000 Hz, 4,000 Hz, and 6,000 Hz taken for each ear in a closed room environment with a minimal ambient noise level of 20–25 dBA. Further information obtained by face-to-face interview with an occupational health nurse at this stage would include any history of hobbies with possible excessive noise exposure such as listening to loud music, singing or karaoke activities, part-time work in a noisy environment, recent ear infection, history of head and/or neck injury, exposure to chemicals and ototoxic medications, or a family history of hearing loss. Severity of NIHL is based on the WHO grading. Hearing within 0–25 dBA or less (better ear) is classified as normal hearing, 26–40 dBA as mild impairment, 41–60 dBA as moderate impairment, 61–80 dBA as severe impairment, and $>$ 80 dBA as profound impairment [10]. These ranges of levels are categorized as such by averaging the hearing level at frequencies 500 Hz, 1,000 Hz, 2,000 Hz, and 4,000 Hz in the better ear. Environmental noise level at the shooting range was not measured owing to inaccessibility.

2.1. Study design and study population

A cross-sectional study was conducted on police personnel (employed by the RBPF) at nonofficer level who were seen for periodic medical examination at the OHD during the period of January 2012 until December 2012. Each person had to have been in service for at least 3 years and a maximum of 30 years. Diagnosis of NIHL was based on (1) history of occupational noise exposure, (2) bilateral hearing loss, (3) hearing loss of $>$ 25 dBA at 4,000 Hz frequency in two consecutive audiograms, and (5) no significant medical history affecting hearing [11]. Other causes of hearing loss needed to be excluded such as nonoccupational noise exposure, ototoxic medications, family history of hearing loss, recent or chronic ear infections, head and neck injury, radiotherapy to the head and neck, and history of mumps. New police recruits during this period were also excluded. Of note, part of the selection criteria to join the RBPF was absence of any hearing impairment. Smoking and alcohol consumption were included as part of the demographic data. In cases where NIHL was diagnosed, the individual was referred to the Ear, Nose, and Throat department at a tertiary hospital for further diagnostic and confirmatory tests.

2.2. Ethical consideration

The study protocol was approved by the Medical Health Research and Ethics Committee of the Ministry of Health, Brunei Darussalam.

2.3. Data collection and statistical analysis

Collection of data was performed by the study team from OHD by reviewing the clinical records. Relevant information was collected from the findings of routine periodic medical examination that police personnel undergo at the OHD. The information was entered into a database for study analysis as well as for the Division's record keeping system. Statistical analysis was done using SPSS version 16 for Windows (SPSS Inc., Chicago, IL, USA). Further analysis was carried out using Pearson Chi-square tests and risk estimation by odds ratio (OR). These variables were further analyzed by multiple logistic regression and OR.

3. Results

A total of 543 police personnel were identified for the period from January 2012 to December 2012. Of this total, 365 were eligible for the study—i.e., there was a presence of occupational noise exposure in the shooting range and traffic noise.

The remaining 178 were excluded from the study population. Demographic details from this group indicated that there were 148 (83.1%) males and 30 (16.9%) females, with a mean age of 36.2 years and a mean duration of service of 15.8 years. The reasons for their exclusion were as follows: hobbies involving frequent singing or karaoke activities, listening to loud music, part-time work in a noisy environment (74, 41.6%); use of ototoxic medications (9, 5.1%); history of head injury (19, 10.7%); family history of hearing loss (19, 10.7%); exposure to solvents (35, 19.7%); and history of chronic ear infection (79, 44.4%).

The descriptive characteristics of the study population and presence of NIHL are presented in Table 1.

The study population was predominantly male (74.8%). The mean age of police personnel was 35.55 years, with a mean duration of service of 14.75 years. The majority of the personnel (43.3%) were Additional Police Officers whose job scope included mainly operational duties, whereas the higher ranks handled more administrative duties. Overall, 64.4% of the study population used

Table 1
Characteristics of study population and presence of NIHL

		Study population ($n = 365$)		Presence of NIHL ($n = 125$)		Excluded population ($n = 178$)
		Mean (SD)	*n* (%)	Male *n* (%)	Female *n* (%)	*n* (%)
Age (y)		35.55 (9.57)				
Sex	Male		273 (74.8)			148 (83.1)
	Female		92 (25.2)			30 (16.9)
Duration of service (y)		14.75 (9.39)				
Presence of NIHL			125 (34.2)	103/273 (37.7)	22/92 (23.9)	60 (33.7)
Age group (y)	20–29		125 (34.2)	11 (10.7)	1 (4.5)	54 (30.3)
	30–39		119 (32.6)	42 (40.8)	2 (9.1)	60 (33.7)
	40–49		79 (21.6)	35 (34.0)	7 (31.8)	40 (22.5)
	50–59		42 (11.5)	15 (14.6)	12 (54.5)	24 (13.5)
Duration of service (y)	10–15		206 (56.4)	41 (39.8)	1 (4.5)	93 (52.2)
	16–30		136 (37.2)	52 (50.5)	16 (72.7)	67 (37.6)
	31–45		23 (6.3)	10 (9.7)	5 (22.7)	18 (10.1)
Rank	APO		159 (43.6)	21 (16.8)	2 (1.6)	70 (39.3)
	PC		71 (19.5)	32 (25.6)	2 (1.6)	31 (17.4)
	LCPL		56 (15.3)	15 (12)	6 (4.8)	33 (18.5)
	CPL		39 (10.7)	17 (13.6)	6 (4.8)	19 (10.7)
	SGT		14 (3.8)	4 (3.2)	3 (2.4)	7 (3.9)
	S/SGT,SGT/MAJ		16 (4.4)	8 (6.4)	1 (0.8)	7 (3.9)
	INSPECT		10 (2.7)	6 (4.8)	2 (1.6)	11 (6.2)
Use of ear defenders	Yes		235 (64.4)	64 (62.1)	14 (63.6)	128 (71.9)
	No		130 (35.6)	39 (37.9)	8 (36.4)	50 (28.1)
Smoking	Yes		162 (44.3)	60 (58.3)	0 (0)	94 (52.8)
	No		203 (55.7)	43 (41.7)	22 (100)	84 (47.2)
Alcohol consumption	Yes		28 (7.7)	9 (8.7)	1 (4.5)	21 (11.8)
	No		337 (92.3)	94 (91.3)	21 (95.5)	157 (88.2)
Diabetes mellitus*	Yes		33 (9)	13 (12.6)	5 (22.7)	18 (10.1)
	No		332 (91)	90 (87.4)	17 (77.3)	160 (89.9)
Hypertension†	Yes		58 (15.9)	27 (26.2)	8 (36.4)	29 (16.3)
	No		307 (84.1)	76 (73.8)	14 (63.6)	149 (83.7)
Hypercholesterolaemia‡	Yes		138 (37.8)	39 (37.9)	11 (50.0)	52 (29.2)
	No		227 (62.2)	64 (62.1)	11 (50.0)	126 (70.8)

APO, Additional Police Officer; BP, blood pressure; CPL, Corporal; INSPECT, Inspector; LCPL, Lance Corporal; NIHL, noise-induced hearing loss; PC, Police Constable; SGT, Sergeant; SGT/MAJ, Sergeant Major; S/SGT, Staff Sergeant.
* Diabetes mellitus—fasting venous blood glucose level $\geq$ 7.0 mmol/L [12].
† Hypertension—BP $\geq$ 140/90 mmHg [13].
‡ Hypercholesterolemia—total fasting cholesterol $\geq$ 5.17 mmol/L [14].

hearing protective devices (ear muffs) during shooting practice, whereas 35.6% were noncompliant with this rule. Moreover, 44.3% were smokers and only 7.7% consumed alcohol.

The results revealed that occupational NIHL was prevalent in 34.2% of police personnel. NIHL was found to be higher in males (37.7%) than in females (23.9%). Males aged 30–39 years (40.8%) and females aged 50–59 years (54.5%) had the highest prevalence rate. Those who served the force for 16–30 years recorded the highest prevalence rate for NIHL in both sexes (50.5% for males, 72.7% for females). Male personnel holding the ranks of Police Constable and Additional Police Officer recorded a high prevalence of NIHL (31.1% and 20.4%, respectively), whereas in females this was largely seen in the ranks of Lance Corporal (27.3%) and Corporal (27.3%). Interestingly, 62.1% of males with NIHL and 63.6% of females with NIHL used ear muffs during shooting practice. There was a higher percentage of nondiabetic, nonhypertensive, and nonhypercholesterolaemic individuals in the NIHL population, with the exception of females in the hypercholesterolemia group, where this was seen to be equal (50%) (Table 2).

The degree of severity of NIHL was further categorized using the WHO grading where the average was taken for readings at the lower frequencies of 500 Hz, 1,000 Hz, 2,000 Hz, and 4,000 Hz, in the better impaired ear [10]. Out of 125 police personnel with NIHL, 45.6% (57/125) were found to have mild to severe NIHL. Of this, the majority (93%) had mild NIHL, 3.5% had moderate NIHL, and another 3.5% had severe NIHL, whereas no police personnel had profound NIHL. There were more males (80.7%) than females who had hearing impairment in the lower frequencies.

Further analyses showed that some of the factors studied have an association with NIHL (Table 3). Factors with a strong association are sex, age, duration of service, rank, diabetes mellitus, and hypertension. Age, duration of service, and rank were found to have a significant association with NIHL by Chi-square test and univariate logistic regression, but it was found that only age has a significant association with NIHL (adjusted OR, 1.1; $P = 0.00$) after stepwise multiple logistic regression. The other two factors had confounding effects on NIHL on stratified analysis.

4. Discussion

Occupational NIHL is a well-recognized condition among police personnel particularly in motorcycle police officers [15–18]. However, only few studies worldwide have been conducted in this

Table 2
Prevalence of NIHL by degree of severity and sex

Grade of NIHL*	Male	Female	Total
	n	*n*	*n* (%)
Mild (26–40 dBA)	43	10	53 (93)
Moderate (41–60 dBA)	1	1	2 (3.5)
Severe (61–80 dBA)	2	0	2 (3.5)
Profound (>80 dBA)	0	0	0 (0)
Total	46	11	57

NIHL, noise-induced hearing loss.
* World Health Organization classification of hearing impairment [10].

Table 3
Factors associated with NIHL

	OR (95% CI)	χ^2 p	Univariate logistic regression		Multiple logistic regression	
			OR (95% CI)	p	OR (95% CI)	p
Sex*	0.51 (0.30–0.8)	5.8 (0.01)			1.9 (1.1–3.4)	0.01
Age group† (y)		63.4 (0.00)	2.5 (1.9–3.2)	0.00	1.1 (1.0–1.1)	0.00
Duration of service† (y)		42.3 (0.00)	3.2 (2.2–4.7)	0.00		
Rank		60.9 (0.00)	1.5 (1.3–1.7)	0.00		
Use of hearing defender‡	1.14 (0.72–1.78)	0.32 (0.56)				
Smoking§	0.80 (0.51–1.23)	1.0 (0.31)				
Alcohol consumption‖	0.93 (0.41–2.08)	0.29 (0.86)				
Diabetes Mellitus¶	0.39 (0.19–0.81)	6.63 (0.01)				
Hypertension**	0.27 (0.15–0.48)	20.8 (0.00)			3.3 (1.8–6.1)	0.00
Hypercholesterolaemia††	0.86 (0.55–1.35)	0.38 (0.53)				

CI, confidence interval; NIHL, noise-induced hearing loss; OR, odds ratio.
* Male (reference group).
† Age and duration of service were categorized into groups for Chi-square analysis but analyzed as continuous variables in stepwise multiple logistic regression.
‡ Uses hearing defender (reference group).
§ Nonsmoker (reference group).
‖ Does not drink alcohol (reference group).
¶ No diabetes (reference group).
** No hypertension (reference group).
†† No hypercholesterolaemia (reference group).

occupational group to evaluate the associated risk factors. In our study, NIHL was noted to be more prevalent among the male police personnel (37.7%) compared to females (23.9%). This is similar to the findings of other studies [19,20], where the prevalence of NIHL was found to be 28% in French police officers, 66.4% in traffic police personnel in Kathmandu City, 81.2% in Pune traffic police in India, and 84% in traffic police in Jalgaon Urban Centre in India. The difference in prevalence may be attributable to the variation in demographic distribution and greater traffic noise pollution in India and Kathmandu than in France. Also, as France is a more developed country, there is better awareness, provision of hearing protective devices, and adequate noise conservation programs in place.

Worldwide, 16% of disabling hearing loss in adults is attributed to occupational noise exposure with the effect of exposure being greater in males than in females [20]. In the United Kingdom, it was estimated that there were 153,000 men and 26,000 women with severe hearing difficulty whose condition could be attributed to occupational noise exposure [21]. Among United States military personnel, the prevalence of NIHL in males was found to be significantly higher than in females [22].

NIHL was also seen to be more prevalent in the 30–49 years age group in males, as well as in groups with > 15 years of service in the police force in Brunei Darussalam. Our result is similar to that of other studies showing that the prevalence of NIHL is directly proportional to increasing age and longer duration of service [19,22].

Our study also showed that the prevalence of NIHL in the group wearing hearing protective devices (ear muffs) was higher than that in the nonhearing defender user group. However, this was not statistically significant, and this could be attributable to improper usage and poor technique when using hearing protective devices. This could also be due to behavioral change for those known to have some hearing impairment resulting in increased use of hearing protective devices in order to prevent further hearing loss. Studies have shown that acute acoustic trauma due to firearm use in military personnel can be prevented by using appropriate ear defenders that are well fitted for the user during planned training exercises [23–25].

Some studies have propounded cigarette smoking as an important factor for the increased likelihood of NIHL because of the increased blood viscosity and decreased oxygenation, both of which contribute to the impairment of cochlear circulation [26,27]. By contrast, there are other studies that were not able to show a relationship between smoking and NIHL. Our result is similar to that of the latter group [28,29].

Many studies have looked into the relationship between preexisting chronic diseases and NIHL, and we attempted to do the same in our local setting in the RBPF. Of the three common chronic diseases studied, only hypertension was found to be statistically significant ($P < 0.001$). This study showed that those with hypertension were 3.3 times more likely to be associated with NIHL than those who were nonhypertensive. Other studies have also supported this finding [30–33]. Repeated and prolonged exposure to industrial noise can cause permanent loss of hearing and act as a contributing factor to the rise in blood pressure through a mechanism involving structural adaption of blood vessels. Therefore, noise may be one of several external stimuli contributing to the development of arterial hypertension in humans.

WHO estimates that globally 16% of individuals have a moderate to greater degree of hearing loss due to occupational noise exposure [20]. In our study population, males made up the majority of those who were found to have NIHL at the lower frequencies. Only a few had moderate (3.5%) and severe (3.5%) NIHL, whereas no police personnel had profound NIHL.

The study team recognizes that there are several limitations to this study. We were unable to measure the exact level of noise exposure, because it was not feasible to conduct environmental noise measurement and personal dosimetry at the workplace including the shooting range, owing to administrative reasons. The OHD took over the health surveillance of police personnel in 2005; therefore, some of the study participants who have been in the service for a long duration may have preexisting hearing impairment during the time when regular audiometry was not a requirement of their health surveillance, hence the absence of baseline audiograms.

In conclusion, NIHL is an incurable but preventable occupational condition. This study shows that increasing age, longer duration of service, and presence of hypertension are significant associated factors for NIHL. Preventative strategies such as adequate provision of a hearing protective device, regular education and training for the employer and employees, implementation of a hearing conservation program at the workplace, and regular health surveillance (audiometry) for police personnel with exposure to excessive noise, can help address the problem.

Our study did not include noise exposure assessment during police shooting practice at the shooting range. Further research could include carrying out fieldwork assessment to identify the exact nature of noise exposure such as impulse or continuous noise, noise levels produced by various types of fire arms, and length of exposure time to excessive noise.

Conflicts of interest

None.

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References

[1] Koh D, Takahashi K. The text book of occupational medicine practice. 3rd ed. Singapore: World Scientific Publishing Co. Pte. Ltd; January 2011. 316 p.
[2] World Health Organization. Facts about Deafness. [cited 2014 Oct.13]. Available: http://www.who.int/pbd/deafness/facts/en/.
[3] Samant Y, Parker D, Wergeland E, Wannag A. The Norwegian Labour Inspectorate's Registry for Work-Related Diseases: data from 2006. J Occup Environ Health 2008;14:272–9.
[4] Ries PW. Prevalence and characteristics of persons with hearing trouble: United States, 1990–1991. Vital Health Stat 1994;10:1–75.
[5] Kiukaanniemi H, Lopponen H, Sorri M. Noise-induced low- and high-frequency hearing losses in Finnish conscripts. J Military Med 1992;157:480–2.
[6] Ylikoski J. Acute acoustic trauma in Finnish conscripts: etiological factors and characteristics of hearing impairments. J Scand Audiol 1989;18:161–5.
[7] McCombe AW, Binnington J, Davis A, Spencer H. Hearing loss and motorcyclists. J Laryngol Otol 1995;109:599–604.
[8] Pierson WR, Mahe JE. Noise and the highway patrolman. J Occup Med (Lond) 1973;15:892–3.
[9] Ross BC. Noise exposure of motorcyclists. Ann Occup Hyg 1989;33:123–7.
[10] World Health Organization - Prevention of Deafness and Hearing Impairment. Report of the Informal Working Group on Prevention of Deafness and Hearing Impairment, Programme Planning. Geneva (Switzerland): WHO/PDH/91.1; 18–21 June 1991.
[11] Kirchner DB, Evenson CE, Dobie RA, Rabinowitz P, Crawford J, Kopke R, Hudson W. Occupational noise-induced hearing loss 2012. J Am Coll Occup Environ Med 2012;54:106–8.
[12] World Health Organization (WHO). WHO Definition, diagnosis and classification of diabetes mellitus and its complication; 1999. World Health Organization. Dept. of Noncommunicable Disease Surveillance. Available from: http://apps.who.int/iris/handle/10665/66040#sthash.3WHayG0y.dpuf.
[13] Willams B, Poulter NR, Brown MJ, Davis M, Mclnnes GT, Potter JF, Sever PS, Thom MS. British Hypertension Society guideline for hypertension management 2004. Br Med J 2004;328:634–40.
[14] National Institute for Care Excellence (UK) guideline May 2008 (reissued March 2010). Cardiovascular risk assessment and modification of blood lipids for the primary and secondary prevention of cardiovascular disease.
[15] Shrestha I, Shrestha BL, Polharel M, Amatya RCM, Karki DR. The prevalence of noise induced hearing loss among traffic police personnel of Kathmandu Metropolitan City. Kathmandu Univ Med J 2011;36:274–8.
[16] Singh VK, Metha AK. Prevalence of occupational noise induced hearing loss amongst police personnel. Indian J Otolaryngol 1999;51:23–6.
[17] Lesage FX, Jovenin N, Deschamps F, Vincent S. Noise induced hearing loss in French police officer. J Occup Med (London) 2009;59:483–6.
[18] Ingle ST, Pachpande BG, Wagh ND, Attrade SB. Noise exposure and hearing loss among the traffic policemen working at busy street of Jalgaon Urban Centre. Transport Res Part D 2005;10:69–75.
[19] Masterson EA, Sang WT, Themann CL, Wall DK, Groenewold MR, Deddens JA, Calvert GM. Prevalence of hearing loss in the United States by industry. Am J Ind Med 2013;56:670–81.
[20] Nelson DI, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. Am J Intern Med 2005;48:1–15.
[21] Palmer K, Griffin M, Sydall HE, Davis A, Pannett B, Coggon D. Occupational exposure to noise and attributable burden of hearing difficulties in Great Britain. Occup Environ Med 2002;59:634–9.
[22] Helfer TM, Canham-Chervak M, Canada S, Mitchener TA. Epidemiology of hearing impairment and noise induced hearing loss among US military personnel, 2003–2005. Am J Prev Med 2010;38:S71–7.
[23] Savolainen S, Lehtomaki KM. Impulse noise and acute acoustic trauma in Finnish conscripts. Number of shorts fired and safe distance. J Scand Audiol 1997;26:122–6.
[24] Mrena R, Savolainen S, Pirvola U, Ylikoski J. Characteristics of acute acoustical trauma in the Finnish Defence Forces. Int J Audiol 2004;43:177–81.
[25] Savolainen S, Lehtomaki KM. Hearing protection in acute acoustic trauma in Finnish conscripts. J Scand Audiol 1996;25:53–8.
[26] Mohammadi S, Mazhari MM, Mehrparvar AH, Attarchi MS. Cigarette smoking and occupational noise induced hearing loss. Eur J Pub Health 2010;20:452–5.
[27] Mizoue T, Miyamoto T, Shimizu T. Combined Effect of smoking and occupational exposure to noise on hearing loss in steel factory workers. J Occup Environ Med 2003;60:56–9.
[28] Starck J, Toppila E, Pyykko I. Smoking as a risk factor in sensory neural hearing loss among workers exposed to occupational noise. Acta Otolaryngol 1999;119:302–5.
[29] Karlsmose B, Lauritzen T, Engberg M, Parving A. A five-year longitudinal study of hearing in a Danish rural population aged 31–50 years. Br J Audiol 2000;34:47–55.
[30] Talbott E, Helmkamp J, Mathews K, Kuller L, Cottington E, Redmond G. Occupational noise exposure, noise induced hearing loss and epidemiology of high blood pressure. Am J Epidemiol 1985;121:501–14.
[31] Toppila E, Pyykko I, Starck J, Kaksonen R, Ishizaki H. Individual risk factors in the development of noise induced hearing loss. Noise Health 2000;2:59–70.
[32] Johnsson A, Hansson L. Prolonged exposure to stressful stimulus (noise) as a cause of raised blood pressure in man. Lancet 1977;309:86–7.
[33] Andren L, Hansson L, Bjorkman M, Jonsson A. Noise as a contributory factor in the development of elevated arterial blood pressure. Scand Med J 1980;207:493–8.