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ORIGINAL ARTICLE

Investigating the Relationship between Lipid Profile as well as Blood Groups and Noise-Induced Hearing Loss in Professional Drivers

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ABSTRACT

Noise-Induced Hearing Loss (NIHL) is one of the most common occupational disorders. Different characteristics of environmental or occupational exposure as well as individual differences trigger NIHL. This study was aimed to evaluate the effect of blood groups, Rhesus (Rh) antigen, and serum cholesterol, triglyceride, and glucose level as risk factors of NIHL. A total number of 1900 drivers who attended the occupational medicine clinic of Baharloo Hospital for the annual health-test of drivers were entered to the study. Pure tone audiometry test was performed for all subjects, blood group, serum cholesterol, triglyceride, and glucose levels were measured. Coles, Lutman, and Buffin's (2000) algorithm were used to identify notched audiograms. A total number of 752 out of 1900 drivers (39.6%) were identified with notched audiograms. No significant difference was observed in serum glucose, cholesterol, and triglyceride between the two groups according to the presence of high-frequency notches. The distribution of blood groups in the study group was as follows: O (36.7%), A (34.1%), B (22.7%), AB (6.5%). There was no significant relationship between blood groups and hearing thresholds or between Rh antigens and high-frequency notch. The results of this study was proved the relationship between age and hearing loss, but did not demonstrate any association between blood groups, Rh antigen, serum cholesterol, triglyceride, glucose levels, and NIHL.

KEY WORDS: *Hearing Loss, Noise-Induced, Hyperlipidemia, Blood Group, Rh Antigen*

INTRODUCTION

Noise is one of the most pervasive and hazardous physical factors in the workplace [1]. Noise exposure negatively affects workers' health. Noise-induced hearing loss is one of the most common occupational disorders which is preventable [2] and the second most common form of sensorineural hearing impairment after presbyacusis [3]. It has been estimated that as many as 500 million individuals over the world are at risk of NIHL [4].

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People have various responses to noise exposure and their sensitivity to noise is different. Thus, at a given level of noise, some of the exposed people may suffer from noise-induced hearing loss [5]. Some factors such as age, gender, race, and family history of ear diseases and metabolic disorders may affect its development [6].

Dyslipidemia is a well-known risk factor for coronary artery diseases and stroke. It has been discussed in some studies that hypertriglyceridemia and high plasma cholesterol levels are risk factors for developing noise-induced hearing loss [7-9]. These studies addressed the hypothesis that the combination of noise and hyperlipidemia increases atraumatic influence by vascular changes and microcirculation disorders in the inner ear [10].

On the contrary, some studies did not demonstrate any relationship between hyperlipidemia and noise-induced hearing loss and showed no consistent differences in the hearing thresholds of the hyperlipidemic population compared to the control groups [11-13].

In addition, some studies investigated the relationship between blood groups and noise-induced hearing loss. Certain diseases have been reported to be more common in particular blood groups [14]. The expression of human blood group antigen on developing cochlear hair cells may be related to afferent nerve fiber influence [15].

Professional drivers are the most susceptible group to high noise levels for long durations [16]. Noise-induced hearing loss (NIHL) can be caused by several factors other than noise, but NIHL can be reduced or prevented.

This study was aimed to evaluate the effect of blood groups, Rhesus (Rh) antigen, and serum cholesterol, triglyceride, and glucose level as risk factors of NIHL.

MATERIAL AND METHODS

Data were collected from 1998 drivers who attended the occupational medicine clinic of Baharloo Hospital in Tehran from April 2014 to March 2015 for the annual health-test of drivers. All drivers were included in this study, after taking the informed consent. A single interviewer collected all data regarding demographic status, medical history, history of trauma or surgery, and measured the participants' blood pressure (systolic and diastolic), height and weight using calibrated standard devices. Body Mass Index (BMI) was used to calculate body weight (kg) which was divided by the square of the height (m2).

Drivers were requested to be in fasting conditions for 12 hours in order to measure serum cholesterol, triglyceride, and glucose levels. Only one laboratory in Tehran was selected to examine the mentioned test based on different blood groups.

Audiometry test was performed for all subjects by an audiologist expert in an acoustic chamber early in the morning. Pure tone audiometry was carried out using clinical audiometer in 0.5, 1, 2, 3, 4, 6, and 8 kHz, meeting ANSI standards. In the current study, Coles, Lutman, and Buffin's (2000) algorithm were applied to identify notched audiograms. In this algorithm, a high-frequency notch defined as "hearing threshold level (HTL) at 3 and/or 4 and/or 6 kHz, after any due correction for earphone type" is at least 10 dB greater than at 1 or 2 kHz and at 6 or 8 kHz.

Drivers who had less than one year of professional driving experience and who had a previous history of acoustic trauma or trauma in their ears were excluded from the study. The remained study population was dichotomized into two categories according to the presence of a high-frequency notch, as defined earlier.

STATISTICAL ANALYSES:

After data gathering, SPSS version 20 was used to find the relationship between exposure to noise and blood biochemical tests, blood pressure and blood groups of drivers. Variable distributions comparison with a normal distribution curve was determined using the Kolmogorov–Smirnov test. A P-value of less than 0.05 was considered significant for all statistical tests. In the current study, Chi square, independent sample T test, and non-parametric equivalent test (Mann–Whitney U test) was used to compare background and metabolic variables between two groups, with or without high frequency notch. In addition, the non-parametric Kruskal-Wallis test was applied to compare the hearing threshold between different blood groups. Bivariate logistic regression analyses with a 95% confidence interval (CI) were calculated the dichotomized outcome and exposure variables, which were significantly related.

ETHICAL CONSIDERATIONS:

Study objectives were explained verbally and written. Participation was selected among voluntary drivers. This study was approved by the Ethics Committee at the Research Division of the Ministry of Health in Tehran.

RESULTS

A total of 1900 drivers were analyzed. All participants were male with an average age of 41.5 years-old (± 10.5) ranging from 21 to 69. Table 1 demonstrates mean and standard deviation (SD) of age, BMI, blood pressure, and blood biochemical tests among the two assessed groups according to a high-frequency notch. 752 out of 1900 drivers (39.6%) were identified with notched audiograms.

The difference between age, BMI, systolic, diastolic blood pressure, serum glucose, serum cholesterol, and triglyceride of the two assessed groups according to the presence of a high-frequency notch was analyzed and no significant difference was observed ($p>0.05$), except for age and BMI. The mean age and BMI increased in drivers with a high-frequency notch in one or both ears ($p<0.001$ and $p=0.006$, respectively).

In addition, the impact of age on blood pressure, serum glucose, cholesterol, triglyceride levels on a high-frequency notch was analyzed by logistic regression test, which have been shown in Table 2. Age and BMI were significantly related to high-frequency notch.

The distribution of blood groups in the study population showed the highest frequency for blood group O with 36.7% and the lowest for AB with 6.5%. In addition, the difference for each of the hearing thresholds (0.5-8kHz) among the blood groups (O, A, B, AB) was analyzed by variance analysis. There was no significant correlation between blood groups and hearing thresholds. The results have been presented in Table 3.

Furthermore, in the current study, the relationship between the Rhesus (Rh) antigens and a high-frequency notch was investigated and no statistically significant difference was determined between the two assessed groups (Odds Ratio= 1.19 and P value= 0.28). The results have been shown in Table 4.

Table 1. The difference between age, BMI, blood pressure, serum glucose, and lipid profile among the two assessed groups, according to a high-frequency notch

Variables	**Notch (+) 752 (39.6%)**	**Notch (-) 1148 (60.4%)**	**P value**
Age [year] Mean (SD)	43.4 (10.3)	40.3 (10.5)	<0.001
Body Mass Index [kg/m^2] Mean (SD)	27.2 (4.3)	26.7 (4.2)	0.008
Systolic Blood Pressure [mmHg] Mean (SD)	120.7 (14.2)	121 (13.9)	0.93
Diastolic Blood Pressure [mmHg] Mean (SD)	79 (7.7)	79 (7.6)	0.64
Serum Glucose [mg/dl] Mean (SD)	107.2 (26.5)	105.7 (26.6)	0.09
Serum Cholesterol [mg/dl] Mean (SD)	194.3 (41.1)	192.4 (43.6)	0.29
Serum Triglyceride [mg/dl] Mean (SD)	177.8 (115.7)	175.2 (119.9)	0.34

Table 2. Logistic regression with high tone notch as dependent variable

Variables	B	S.E.	Sig.	Exp(B)
Age	0.03	.005	0.00	1.03
Systolic Blood Pressure	-0.01	.005	.06	0.99
Diastolic Blood Pressure	0.00	.008	.74	1.00
Blood Glucose	0.00	.002	.72	1.00
Body Mass Index	0.03	.012	.004	1.03
Cholesterol	0.00	.001	.88	1.00
Triglyceride	0.00	.000	.73	1.00
Constant	-1.45	.595	.01	0.23

Table 3. Hearing thresholds in drivers with different blood groups

Blood Group	0.5 kHz Mean (SD)		1 kHz Mean (SD)		2 kHz Mean (SD)		3 kHz Mean (SD)		4 kHz Mean (SD)		6 kHz Mean (SD)		8 kHz Mean (SD)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
A	9.8	10	9	9.6	9.6	10.8	13.4	15.7	18.4	21.9	18.4	21.8	19.4	21.4
N= 638 (34.1%)	(7)	(7.6)	(7.9)	(9.5)	(10.4)	(13.2)	(13.7)	(15.5)	(17.5)	(19)	(17.7)	(19.6)	(19.1)	(20)
B	9.7	10.2	9.2	10.1	9.7	11.7	14.5	17.2	19.5	22.1	19.1	21.8	19.6	21.6
N= 426 (22.7%)	(8)	(9.6)	(9.4)	(11.9)	(10.7)	(15.1)	(14.8)	(18)	(18.7)	(20.2)	(18.8)	(20.5)	(19.9)	(21.1)
AB	9.1	9.9	8.7	9.4	9.1	10.7	13	14.4	18.2	20.4	17.2	20.6	19.3	20.9
N= 121 (6.5%)	(7.9)	(10.8)	(8.9)	(12.1)	(11.5)	(11.6)	(14.3)	(13.6)	(17.7)	(17.5)	(18.2)	(17.9)	(19.3)	(17.9)
O	9.4	9.5	8.6	9	8.8	10.1	13.1	15.4	18.8	21.5	18	20.8	19	20.9
N= 688 (36.7)	(6.8)	(7.4)	(7.7)	(8.7)	(9.2)	(11.6)	(12.8)	(13.8)	(16.9)	(17.5)	(16.2)	(16.9)	(18.4)	(18.1)
P value	0.36	0.20	0.48	0.39	0.75	0.78	0.74	0.77	0.87	0.84	0.64	0.93	0.98	0.95

Table 4. The relationship between the Rh antigens and high-frequency notch

	Notch (+)	Notch (-)	Total
Rh- positive	663 (39.1%)	1033 (60.9%)	1696 (100%)
Rh- negative	77 (43.3%)	101 (56.7%)	178 (100%)
Total	740 (39.5%)	1134 (60.5%)	1874 (100%)

DISCUSSION

Noise is an important environmental pollutant and a common burden of life in large cities [16]. Prolonged time spending outdoors exposed the drivers to noise, as one of the important physical hazards. Hearing protection of drivers is an essential factor to protect their health and safety. In the present study, the impact of blood groups on Rh antigens, blood pressure, serum cholesterol, triglyceride, and glucose levels was investigated on hearing loss. The findings of previous studies regarding this issue proposed different results.

One case control study conducted by Chang et al. analyzed the relation between TG and cholesterol level and noise-induced hearing loss. Their data were collected from routine health-test of workers exposed to noise greater than 85dB over a one-year period. They reported that hypertriglyceridemia was associated with NIHL after adjustment for age and gender, but hypercholesterolemia was not observed [17]. The same results were obtained from the study of Doosti et al. which conducted on 144 workers of a textile factory, exposed to continuous noise of more than 85dB [18]. Some other previous studies reported that hypertriglyceridemia and high plasma cholesterol levels are risk factors for developing noise-induced hearing loss. However, the majority of these reports had small sample sizes and did not have adequate controls and may represent incidental findings, not a true causal relationship, as hyperlipidemia is a prevalent finding in the normal population.

On the contrary, a retrospective case-control study by Jones and Davis in 2000 examined the relationship between blood pressure, fasting glucose, triglyceride or fasting cholesterol levels, and sensorineural hearing loss in 1490 patients which examined in their neurology clinic. They showed that after controlling variables like age and sex, there was no significant association between hearing and blood pressure, fasting glucose, triglyceride or fasting cholesterol. However, a general linear interactive modeling application showed that the total fasting cholesterol was associated with significantly better hearing threshold levels [11]. In two separate studies conducted by these groups in 1999, no consistent association was found between hyperlipidemia and hearing loss [12-13]. In a similar study by Pulec et al., it was found that only 120 of 2332 patients (5.1%) who had complaints of hearing loss, had dyslipidemic symptom [19].

In a study on 1662 patients from the Framingham cohort, Gates et al. evaluated the possible association between hearing, cardiovascular risk factors, and events over a 6-year period. There was no relationship between any of the hearing variables and serum cholesterol or triglyceride levels. An inverse relationship between age-adjusted, High-density lipoprotein (HDL) levels, and hearing loss was significant among women [20]. In a meta-analysis study by van Kempen et al. with respect to the association between air traffic noise exposure and blood pressure, small blood pressure differences were evident [21]. Moreover, a cross-sectional study on 790 male workers in an aircraft manufacturing company concluded that a mean hearing threshold exceeding 15 decibels at 4 kHz or 6 kHz bilaterally over a 5 year has increased the risk of hypertension [22].

Our study supported the null hypothesis stating that the distribution of plasma lipid levels was not significantly different in populations with noise-induced hearing loss compared to control groups. Analysis of the variance of variables and control variables such as age and BMI showed no significant association between hyperlipidemia and NIHL. Although logistic regression analysis showed that BMI was a statistical difference between the two groups according to the presence of high-frequency notches, this difference was not clinically important (27.2 ± 4.3 vs. 26.7 ± 4.2).

There was another hypothesis indicating the ABO blood group and Rh antigens as important factors in determining genetic variation and individual susceptibility of ears to noise-induced hearing loss. In a study by Nuray Bayar Muluk et al. which carried out 18 male workers in steel working factory, it was concluded that workers with blood groups A and AB may be more prone to high frequencies hearing loss [23] whereas Dogru et al. found this susceptibility in people with O blood group [14]. Another study by Aycicek et al. demonstrated no significant difference between ABO blood groups and the intensity of noise-induced hearing loss but they showed a positive relationship between Rh-positive and NIHL [24]. The present study did not found any association between blood groups as well as Rh antigen and hearing loss.

NIHL is a major cause of hearing impairment. Developing NIHL is the result of modifiable and non-modifiable risk factors. Non-modifiable factors include genetics, gender, race, and age which play the most important role. The risk of NIHL increases with advancing years [25]. After an identical noise exposure not all subjects develop hearing loss [3], there are significant differences between individuals in susceptibility to noise damage, indicating the possibility of genetic variability in response to noise exposure [26-27].

In addition, several modifiable factors including cigarette smoking, lack of exercise, low intake of antioxidant vitamins, minerals, and presence of diabetes have been proposed as risk factors of NIHL [25]. As well as individual factors, characteristics of environmental or occupational exposure to noise are important factors. These factors were noise intensity, working conditions, a distance of the sound source, and exposure period. Environmental factors interact with putative NIHL genes [3]. In this study, all subjects had the same job with similar work environments. Therefore, their susceptibility to hearing loss can be due to their individual differences such as age and genetic variability.

LIMITATIONS OF THE STUDY

The major strength of this study was the inclusion of a large sample from professional drivers and assessing the effect of metabolic factors and blood groups on noise-induced hearing loss in this occupational group. We were not able to test the effect of some environmental and occupational factors such as vehicle type, duration of their experience as a professional driver, and smoking status of the drivers on our study results due to lack of these data. Moreover, cross-sectional studies did not scientifically explain a cause and effect relation, but an acceptable sample size can empower the mentioned hypothesis.

CONCLUSION

The results of this study was proved the relationship between age and hearing loss, but did not demonstrate any association between blood groups, Rh antigene, serum cholesterol, triglyceride, and glucose levels and NIHL

CONFLICT OF INTEREST

The authors declare that no conflict of interest exists.

FUNDING

The authors declare that no relevant financial interests exist in this manuscript.

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