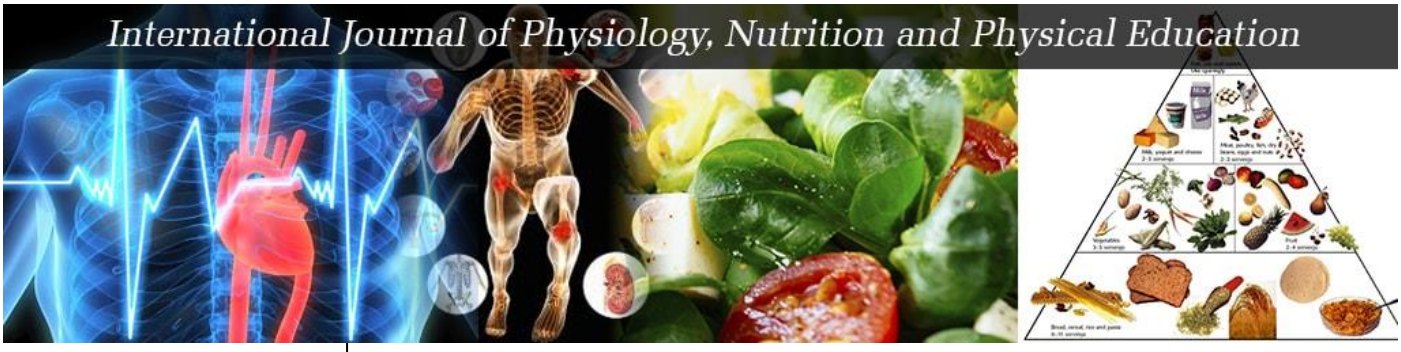

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Ashwini K Shetty
Associate Professor, Department of Physiology, MVJ Medical College & Research Hospital, Hoskote, Bangalore, Karnataka, India

Vinutha Shankar MS
Professor & HOD, Department of Physiology, Sri Devaraj Urs Medical College, Kolar, Karnataka, India

Karthiyanee Kutty
Professor, Department of Physiology, Sri Devaraj Urs Medical College, Kolar, Karnataka, India

Correspondence
Vinutha Shankar MS
Professor & HOD, Department of Physiology, Sri Devaraj Urs Medical College, Kolar, Karnataka, India

Effect of cigarette smoking on hearing thresholds using pure tone audiometry

Ashwini K Shetty, Vinutha Shankar MS and Karthiyanee Kutty

Abstract
Introduction: Smoking is widespread addiction among youth and is extensively practiced despite of its harmful effects. Smoking effects all the systems in the body but a little is known about the effects of smoking on hearing thresholds, although link was established 40 years ago, information on the effects of smoking at the cochlear and auditory central nervous system levels has become available recently. The present study aims at studying whether cigarette smoking causes any changes in auditory thresholds in smokers as compared to age matched non smoker.
Materials and Methods: The study included 50 male smokers of age group between 20-40 years and 50 age matched male non smokers, who were selected based on inclusion and exclusion criteria. These subjects were recruited from teaching, non teaching staff of Sri Devraj Urs academy of higher education and research and also attenders of the patients coming to R.L. Jalappa hospital. After taking informed consent and data regarding their smoking history (expressed in pack -years), they were subjected to pure tone audiometric evaluation and test results were entered in audiogram. The data thus obtained was treated with appropriate statistical test like student t test.
Results: There was statistically significant difference in auditory air and bone conduction thresholds at all frequencies for both right and left ear.
Conclusion: Smoking causes increase in both air conduction and bone conduction thresholds at all frequencies

Keywords: Pure tone audiometry, cigarette smoking

Introduction
Smoking is widespread addiction among youth and is extensively practiced despite of its harmful effects. Smoking is a greater cause of death and disability than any single disease, says the World Health Organisation. Tobacco smoking is a known or probable cause of approximately 25 diseases, and even the WHO says that its impact on world health is not fully assessed. Tobacco consumption has been explicitly linked to high incidence of heart diseases. A little has been known about the effect of smoking on auditory thresholds although link was established over 40 years ago; information on the effects of smoking at the cochlear and auditory central nervous system levels has become available only recently.
A few population based studies have shown relation between smoking and hearing loss.[1,2] An experimental study have concluded that cigarette smoking results in structural modifications of the cochlea and tuba acoustica.[3]
The present study aims at observing the association between smoking and changes in hearing thresholds in a sample population of Kolar.

Objectives
1. To record auditory thresholds in smokers of age group 20-40 years using pure tone audiometer.
2. To compare the auditory thresholds for various frequencies of smokers and age matched non-smokers.

Materials and Methods
The study group consisted of 50 cigarette smokers and 50 age matched non smokers. The subjects were recruited based on various inclusion and exclusion criteria from teaching and

non teaching staff of Sri Devraj Urs Academy of Higher Education and Research and also attenders of patients coming to R.L.Jalappa Hospital, Kolar after taking informed consent. Ethical clearance was also obtained from Institutional Ethical Clearance Committee for the study.

Inclusion criteria

Study group included

1. Male smokers of age group between 20 and 40 years.
2. Subjects who are not exposed to occupational noise.

Control group included

1. Non smoking males of age group between 20 and 40 years.
2. Subjects who are not exposed to occupational noise

Exclusion criteria

Study group

1. Subjects over 40 years of age.
2. Subjects with history of use of ototoxic drugs like streptomycin, cisplatin, neomycin, gentamycin.
3. Subjects with chronic medical illness like diabetes, hypertension etc.
4. Subjects with history of head injury and history of ENT infections in past 3 months.

Control Group: Same as above subjects being non smokers. Based on above predetermined inclusion and exclusion criteria, subjects were divided into study (smokers) and control (non smokers).

Study subjects thus selected were given a questionnaire to collect information regarding their smoking history. A detailed general physical and systemic examination was conducted in all subjects. Also a detailed ear, nose and throat examination was carried out to rule out any unidentified pathology.

An assessment of auditory thresholds was done for different frequencies by using pure tone audiometer (ELKON-GIGA3) for both study and control groups in a sound proof room.

Pure tone audiometer contains sound thresholds in decibels and frequencies in Hertz.

Auditory threshold is the lowest level of sound threshold in decibels, at a particular frequency of sound at which the human ear can perceive it as a sound. The parameters studied in pure tone audiogram are air conduction (AC) and bone conduction(BC) hearing thresholds of both the ears at various frequencies of sound.

They are recorded on audiogram chart which depicts the auditory thresholds of the particular ear. The audiogram was recorded for both the ears separately.

The data collected was entered in master chart and statistically analysed using appropriate statistical test. The data was suitably arranged into tables for discussion under different headings. Descriptive statistical analysis was carried out on this data. Results on continuous measurements are presented as mean + standard deviation and results on categorical measurements are presented in number. Significance was assessed at 5% level of significance. AC, BC hearing thresholds recording was compared between cigarette smokers and age matched non smokers using student t test.

Results & analysis

The study included 50 male cigarette smokers of age group between 20-40 years and 50 age matched male non smokers, who were selected based on inclusion and exclusion criteria. After which they were subjected to pure tone audiometric evaluation. The data obtained was analysed using appropriate statistical methods.

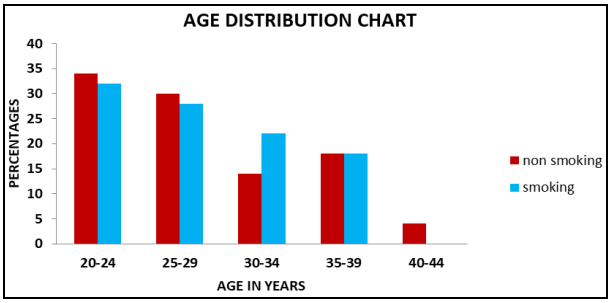
The study groups are age matched with p=0.376(Table 1).

Results showed that there is significant difference in AC thresholds between smoker and non smoker groups at all frequencies in both right and left ear with p<0.001. (Table 2, 3 & Graph 2, 3).

There significant difference in BC thresholds between smoker and non smoker groups at all frequencies in both right and left ear with p<0.001. (Table 4, 5 & Graph 4, 5).

Table 1: Shows age distribution of subjects included in the study. The study groups are age matched with p=0.37

Age in years	Smokers		Non-Smokers	
	No	%	No	%
20-25	15	30.0	16	32.0
26-30	17	34.0	19	38.0
31-35	11	22.0	7	14.0
36-40	7	14.0	8	16.0
Total	50	100.0	50	100.0
Mean ± SD	29.14±5.28		28.16±5.73	

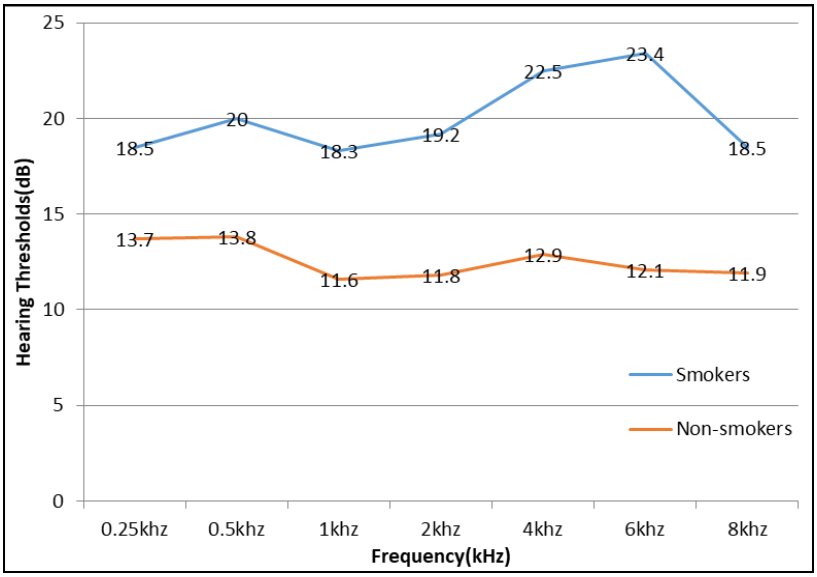


Graph 1: Age distribution of subjects studied

Table 2: Comparison of AC thresholds in decibels between smokers & non smokers in right ear.

Frequency (right ear)	AC		
	Smokers	Non-Smokers	p value
0.25khz	18.50±6.94	13.70±4.61	<0.001**
0.5khz	20.00±6.85	13.80±3.72	<0.001**
1khz	18.30±8.84	11.60±3.42	<0.001**
2khz	19.20±9.66	11.80±5.42	<0.001**
4khz	22.50±10.11	12.90±5.98	<0.001**
6khz	23.40±10.76	12.10±5.06	<0.001**
8khz	18.50±11.17	11.90±5.14	<0.001**

Results are presented in mean ± SD, Student t test has been used to compute p value

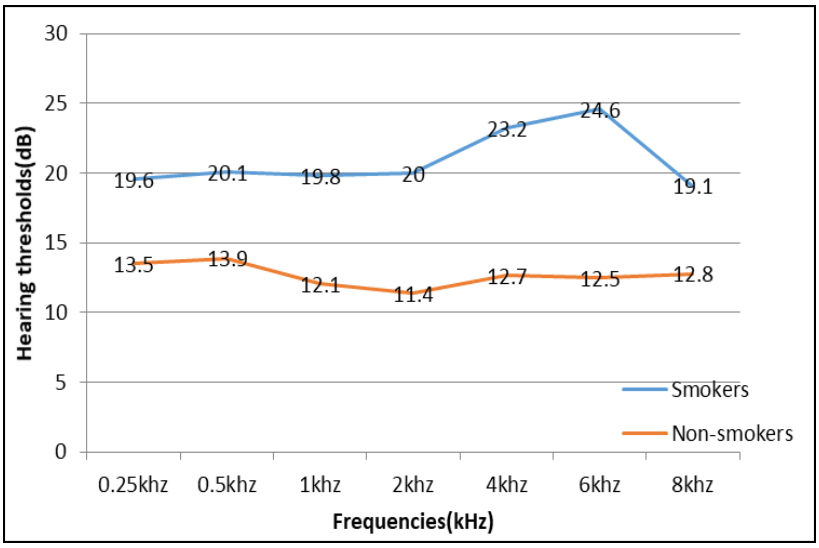


Graph 2: Comparison of AC thresholds in decibels between smokers & non smokers in right ear

Table 3: Comparison of AC thresholds in decibels between smokers & non smokers in left ear.

Frequency (left ear)	AC		
	Smokers	Non-Smokers	p value
0.25khz	19.60±6.21	13.50±4.87	<0.001**
0.5khz	20.10±6.66	13.90±4.77	<0.001**
1khz	19.80±9.53	12.10±4.05	<0.001**
2khz	20.00±9.58	11.40±5.05	<0.001**
4khz	23.20±11.19	12.70±5.64	<0.001**
6khz	24.60±11.9	12.50±5.37	<0.001**
8khz	19.10±10.38	12.80±5.90	<0.001**

Results are presented in mean ± SD, Student t test has been used to compute p value

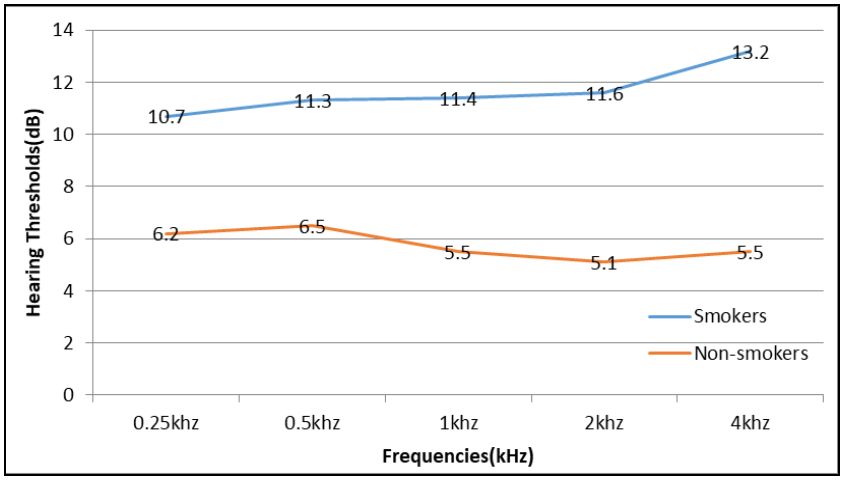


Graph 3: Comparison of AC thresholds in decibels between smokers & non smokers in left ear.

Table 4: Comparison of BC thresholds in decibels between smokers & non smokers in right ear.

Frequency (right ear)	BC		
	Smokers	Non-Smokers	p value
0.25khz	10.70±5.72	6.20±2.96	<0.001**
0.5khz	11.30±5.70	6.50±2.90	<0.001**
1khz	11.40±7.22	5.50±3.07	<0.001**
2khz	11.60±8.66	5.10±3.98	<0.001**
4khz	13.20±8.68	5.50±3.68	<0.001**

Results are presented in mean ± SD, Student t test has been used to compute p value

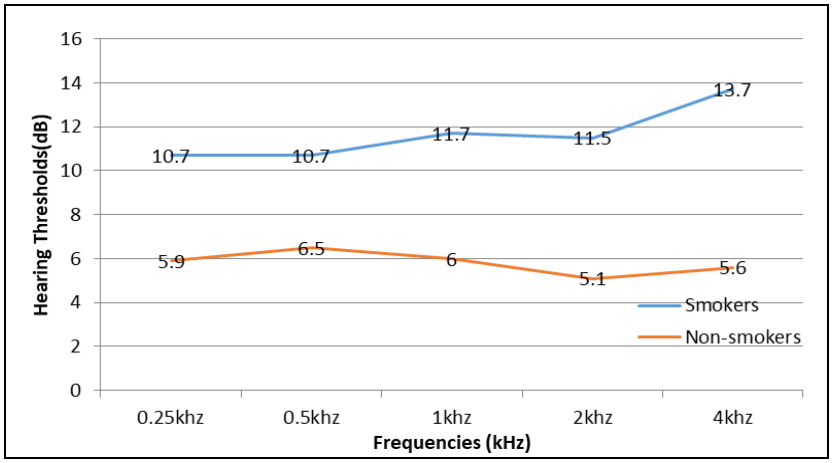


Graph 4: Comparison of BC thresholds in decibels between smokers & non smokers in right ear

Table 5: Comparison of BC thresholds in decibels between smokers & non smokers in left ear

Frequency (left ear)	BC		
	Smokers	Non-Smokers	p value
0.25khz	10.70±5.63	5.90±3.30	<0.001**
0.5khz	10.70±5.63	6.50±3.07	<0.001**
1khz	11.70±7.26	6.00±3.19	<0.001**
2khz	11.50±8.7	5.10±3.71	<0.001**
4khz	13.70±8.85	5.60±3.87	<0.001**

Results are presented in mean ± SD, Student t test has been used to compute p value



Graph 5: Comparison of BC thresholds in decibels between smokers & non smokers in left ear

Discussion

Cigarette smoking is associated with numerous diseases like head and neck cancer, lung cancer, atherosclerosis, coronary and heart diseases. Information on the effects of smoking at the cochlear and auditory central nervous system levels has become available only recently [1, 2, 3].

This study was taken up compare low and high frequency auditory thresholds among a group of smoking and non-smoking male individuals between 20 and 40 years.With increasing age there is physiological alteration in hearing acuity called "presbyacusis" hence age was resticted to 40 years of age.

Present study showed that there was statistically significant difference in auditory air and bone conduction thresholds at all frequencies for both right and left ear between smokers and non smokers. The smoker group had higher threshold of hearing at all frequencies as compared to age matched non smokers indicating smoking affects both air and bone conduction auditory thresholds. Similar results were shown in a study which compared the auditory thresholds, within a group of male smokers and non-smokers aged between 18 and 40 years [4].

Studies have also shown that the percentage of hearing loss was greater for smokers at all measured frequencies [5]. A longitudinal study done on non hearing impaired Japanese male office workers over a period of 5 year showed that the relative risk of low and high frequency hearing loss was higher among smokers as compared to never smokers [2]. Also, men who smoked more than one pack per day had worse hearing thresholds at 250 to 1000 Hz than non smokers or light smokers but no difference at higher frequencies was documented in another study [6]. Association ofsmoking with higher prevalence and incidence of hearing loss was shown by various cross sectional, prospective and case control studies in literature [7, 8, 9].

The possible explanation for conductive hearing loss among smokers may be a higher prevalence of rhino sinusitis or eustachian tube dysfunction [10, 11, 12, 13]. Sensorineural hearing loss might be due to an oxidative damage caused by toxic substances inhaled with the cigarette smoke [3].

There is no direct evidence for the mechanisms of damage to the auditory system associated with cigarette smoke exposure. It may be related to hypoxia; both nicotine & carbon monoxide in cigarette smoke may induce vasospasms and deplete oxygen levels to the cochlea as well as spiral ganglion cells [14, 15, 16, 17]. Recent studies have also indicated that the mechanism that may be due to the interaction between nicotine and nicotinic acetylcholine receptors (nAChRs) within the auditory system. Nicotine binds to nAChRs that normally modulate the effects of a neurotransmitter called acetylcholine. Since neurotransmitters function as chemical message carriers facilitating communication between cells by binding to the receptors on the cell surface, loss or damage of the receptors would eliminate the modulatory influences of the receptors. There is now evidence that nAChRs are critical components of the auditory pathway, from the cochlea to the temporal lobe, and the descending auditory pathway [18, 19]. Moreover, emerging data indicates that prenatal exposure to nicotine or chronic nicotine use during adolescence damages the nAChR binding sites, producing cognitive impairments in the auditory and visual modalities [20, 21, 22]. Finally, the neurophysiological mechanism that may potentially explain the association between adolescent smoking and neurocognitive deficits is protracted development of the auditory central nervous system pathways. There is evidence that many components of auditory central nervous system development, including the auditory thalamocortical and cortigofugal pathways, continue into late adolescence [21, 22, 23]. Moreover, these pathways are particularly susceptible to damage, if environmental toxins like nicotine are introduced during their developmental emergence [20, 24].

Studies have also found negative association between smoking and hearing loss, The longitudinal study of aging done at Baltimore, found no association between cigarette smoking and development of hearing loss in 531 white men [25]. A study which tested hearing with audiometry done at Framingham showed that there is no association between cigarette smoking and hearing loss [26]. A possible explanation for this discrepancy in results may be the different methodologies used in the studies and the fact that they related to different populations (Spanish and North Americans) at different ages.

Conclusion

The present study aimed at observing the association between smoking and changes in auditory thresholds in a sample population of Kolar revealed that, Smoking causes increase in both air conduction and bone conduction thresholds at all frequencies.

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