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Hazards of Noise Pollution on the Hearing of Young Adults: A Prospective Study at Liaquat University of Medical and Health Sciences, Jamshoro

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Abstract:

Background: *Noise produce drastically adverse effects on the hearing of persons who are exposed to excessive level of noise on persistent bases.*

Objective: *To estimate the relationship of noise pollution and adverse hearing effects.*

Methodology: *This prospective comparative study was conducted in the department of physiology in collaboration with department of ENT Liaquat university of medical & health sciences Hyderabad for 06 months from 1ST January 2013 to 30 June 2013. The study was designed to include 200 volunteers. They were selected from the Liaquat university of Medical & Health sciences Jamshoro (LUMHS) and the out Patient Department (OPD) of Liaquat University hospital Hyderabad (LUH) after an extensive scrutiny by*

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questioner, Otoscopy examination and tuning fork test. Objective of this study were completely explained to them and verbal as well as written consent was taken. These volunteers were divided into control and test group.

Result: *No participant in the non-exposed group was suffering from hearing loss and tinnitus. In the test group 87 (58%) were suffering from hearing loss while 45 (30%) were suffering from tinnitus. In the test subgroups 33 (66%) in the industrial, 31 (62%) in the traffic and 23 (46.0%) were suffering from hearing loss while 17 (34.0%) in the industrial, 16 (32.0%) in the traffic and 12 (24.05) in the music group were suffering from tinnitus.*

Conclusion: *Noise produce drastically adverse effects on the hearing of persons who are exposed to excessive level of noise on persistent bases.*

Key words: Noise, hearing loss, tinnitus

Introduction

Sound is defined as " sensation perceived by ear when vibrating air particles strike the tympanic membrane". Noise is "unwanted, loud and distracting sound"[1] (Hameed et al 2010). Intensity or the loudness of Sound is measured in decibel; Acoustic Society of America label 0(zero) dB at a pressure level of 0.000204 dynes/cm^2 as the reference level (Barrett et al 2010). Sound is an effective mean for communication and day to day functioning (Mohindra &Venugopalachar 2011)[2].

The rapid urbanization and industrialization, has increased the incidence of hearing loss among the workers who are frequently exposed to noise pollution[3] (Ashraf et al 2009). Industrial noise is one of major environmental factor producing both auditory and non auditory effects. In auditory effects NIHL and in non auditory effects sleep disturbance, annoyance, mental lethargy, impaired performance and

Psychological upset are the major outcome of industrial noise[4] (Mahindra Prashanth K V et al 2008).

The rapid popularity of personnel stereo system, noisy sports and gunshots in every gathering have increased the risk of hearing loss[5] (Ramma et al 2011). As the Personnel music system .e.g.Mp3, Mobile songs, CDs and IPods players are getting popularity in the new generation, millions of peoples are putting them self at a higher risk of getting deaf. The use of ear phones has increased the risk of hearing loss. The insert Ear phones are more destructive then the bigger and covering phones[6] (Kumar A et al 2009). Music produces less damage than industrial noise but produces more tinnitus[7] (Topila et al 2011). By putting music in the criteria of noise may be considered as a step against an art form. But music expert believe that there is a definite link between high frequency music sound and hearing loss[8] (Chesky et al 2009). Previous researches indicate that 60% of maximum stereo volume produces NIHL (Rekha et al 2011).[9]

Traffic stream has contributed a lot for the welfare of human civilization but mounted a great burden on hearing[10] (Dibyendu Banerjee 2012). Traffic noise is one of the major shareholders in noise pollution. Most of the workers involved in Traffic industries are under a lot of stress because of air and noise pollution leading to detoriation of their hearing status (Karimi A et al 2010)[11].

Noise induced hearing loss (NIHL) is defined as "cumulative, progressive and preventable disease produced by the repeated exposure to loud sound over a long period of time[12] (Kirchner 2012). It is an increase in hearing threshold level above 30dB for average 0.5KHz, 1KHz, 2kHz and 50dB at 4kHz (Chung et al 2012)[13].

About 5.2 millions children and adolescent and 26 million adults are suffering from noise induced hearing loss. There are 250 million adults are suffering from hearing

Impairment throughout the world. According to WHO, It is the 3rd most prevalent diseases and it will be 10 most frequent complaint by 2030[14] (Hasson D et al 2011). Seventeen percent of teens usually lose some of their hearing as they grow up due to noise pollution[15] (Rawool et al 2008). There are evidences that noise leads to early onset of Presbycusis[16] (Fligor 2009).

Occupational Society and Health Administration (OSHA) has prescribed different levels of noise i.e. 30dB for whisper, 100dB for stereo headphones and 140 to 170dB for gunshot[17] (Rabinowitz 2000). ISO 1999 standardized 85dB per day with 3dB exchange rule (for every 3dB increase in noise, exposure time should be half), as the maximum exposure dose of sound energy for different occupations but still this may cause permanent hearing loss in many people[6] (Kumar et al 2009). For every 20dB increase in hearing threshold, there is twofold increase risk of hearing loss[18] (Rubak et al 2006). NIHL usually starts with high frequency sound, it is not recognized early and not taken seriously[19] (Vogel et al 2010). In developing countries peoples are though highly exposed to noise at their work places but they are unaware about the health hazards[20] (Dube et al 2011).

Noise produces damaging effect on Cardiovascular System, Central Nervous System Human Psychology. These include Hyperlipedemia, Hyperprotenemia and Hypertension and most important hearing loss[21] (Khan et al 2010). Hearing loss produces disability in language processing, social connectivity and emotional behavior[22] (Agrawal et al 2008). Strong acoustic trauma not only damages the ear drum but also the delicate micromechanical arrangement of sterocillia and membrane k^+ channel[23] (Harrison 2008). Exposure to sudden loud noise produces transient threshold shift(TTS) indicating temporarily impairment of hearing which is directly proportional to exposure time but

repeated TTS produces cochlear cellular damage and permanent threshold shift (PTS) Indicating permanent hearing loss (Petrescue 2008)[24].

Tinnitus is another disabling disorder which is produced by loud sound. Loud sound either initiates tinnitus or aggravate already existing disorder[25] (Henry et al 2009). Tinnitus is produced either by re designing of tonotropic maps in the auditory area or by the involvement of limbic area[26] (Muhlau M et al).

Purpose of Study

To study the effect of noise pollution on the hearing of young adult population of Hyderabad Sind.

Methodology

This prospective comparative study was conducted in the department of physiology in collaboration with department of ENT Liaquat university of medical & health sciences Hyderabad for 06 months from 1ST January 2013 to 30 June 2013

Data collection:

The study was designed to include 200 volunteers. They were selected from the Liaquat university of Medical & Health sciences Jamshoro (LUMHS) and the out Patient Department (OPD) of Liaquat University hospital Hyderabad (LUH) after an extensive scrutiny by questioner, Otoscopy examination and tuning fork test. Objective of this study were completely explained to them and verbal as well as written consent was taken. These volunteers were divided into control and test group.

To conduct the study, Permission was taken from the Ethical committee of Post graduate studies of LUMHS. A

written consent was taken from the department of Physiology and Department of ENT to conduct different tests. Using the inclusion and Exclusion criteria, Questionnaire Performa, otoscopic examination and tuning fork tests, the Participants were selected Audiometric evaluation on the selected participants. The inclusion and exclusion criteria was designed as under

Inclusion criteria:

Young adults with age range 15 to 40 years, Control group with no history of hearing problems and no exposure to loud sound for 30 hours per week for 2 years, Test groups of industrial workers, Residents near the industrial units, professional drivers ,residents near the busy roadside with history of hearing difficulties and exposure to loud sound for 30 hours per week for 2 years, persons using personal listing devices for 30 hours per week for 2 years and are suffering from hearing difficulties, Persons having bilateral sensorineural type of deafness, Persons who are resident of Hyderabad Sind.

Exclusion criteria:

Individual of age group Below 15 years and above 40 years, persons having less duration of noise exposure, no Previous H/o chronic ear infection with discharge e.g. CSOM, no History of ototoxicity by drugs, no History of Hypertension, history of Diabetes mellitus, unilateral sensorineural hearing loss, history of chronic suppurative otitis Media (CSOM), all cases of conductive hearing loss, any congenital anomaly of ear, history of otic trauma, history of Meniere's diseases.

All data including history, clinical examination, and test results were incorporated in a specially designed Performa.

Statistical analysis:

Statistical analysis was done on SPSS version 16. All the

variables were categorical. Study was analyzed for two types of variables, Dependent and independent or outcome variables. The outcome variables was noise induced hearing loss and Tinnitus. The independent variables were included Age, gender, Duration of exposure per day, Total period of exposure (in years), loudness of noise, types of the noise and use of Hearing protecting devices. Descriptive statistic was performed to assess the frequencies of different variables. Cross tab was used to determine the association between independent and dependent variables. Chi square test was applied to determine the P value. P value less than 0.005 was noted as significant.

Ethical consideration:

The study was conducted strictly under the ethical rules after the approval from ethical committee of LUMHS Jamshoro.

Subjects selected were called in the department where a detailed history was taken and Blood pressure was recorded. Verbal and written consent was taken from all subjects about this study. The method of selection comprised of questioner evaluation, otoscopic examination and tuning fork test. After the selection a comprehensive audiometric examination was carried on the participants.

A detailed Questioner was distributed among these subjects in order to select only those who fulfill the criteria of this study. Specific questioners Performa was filled by the participating to gain knowledge about their Bio data, occupation, History specifically of ENT related history, Nature of noise exposure, Duration of job, working hours, Use of Hearing Protective Devices, different associated diseases which were associated with outcome variables and Hobbies in relation to music exposure and behavior during the working hours etc.

After the step of questioners a detailed clinical examination was conducted to evaluate any pre-existing occlusive, genetic and infective diseases. A thorough clinical examination was

performed with the help of Head light and aural speculum especially local ENT examination, involving examination of Pinna, External auditory canal, Tympanic membrane and its movement.

All those participants who were found having wax, foreign bodies in external auditory canal, immobility of Tympanic membrane, loss of cone of light, bulging and retraction of tympanic membrane were discarded from the study. All those who were found having no cerumen occlusion, normal tympanic membrane mobility were included in the study.

For bed side clinical tests tuning Fork of 512 Hz was used. This specific frequency was used because it is better heard than felt. It vibrates very close to original frequency without overtones. The fallowing hearing tests were performed.

Results

Age wise participants were divided into five groups. Each group comprised of five participant of a specific age group .e.g. 15-20 years were 83 (41.5%), 21 to 25 years were36(18%).26 to 30 years were 26 (13%),31 to 35 years were 35(17.5%) and 36 to 40 were 20 in numbers (10%). Regarding gender distribution were females 73(36.5%) and one Hundred and twenty seven (63.5%) were males. No participant in the non exposed group was suffering from hearing loss and tinnitus. In the test group 87 (58%) were suffering from hearing loss while 45 (30%) were suffering from tinnitus. In the test subgroups 33 (66%) in the industrial, 31 (62%) in the traffic and 23 (46.0%) were suffering from hearing loss while 17 (34.0%) in the industrial, 16 (32.0%) in the traffic and 12 (24.05) in the music group were suffering from tinnitus. P value (0.000) indicates close association between noise, hearing loss and tinnitus.

In 15 to 20 years 19(44.2%), In 21 to 25 years24(66.7%), In 26 to 30 years 15(57.7%), In 31 to 35 years 18 (62.1%0 , In

36 to 40 years 11 (68.8%%) were suffering from hearing loss while 13 (30.2%) in 15 to 20 year's age group, 9 (25%) in 21 to 25 years age group, 9 (34.61%) in 26 to 30 year's age group and 8 (27.58%) in 31 to 35 years age group and 6 (37.5%) were suffering from tinnitus The P value indicate no specific link between age, hearing loss and tinnitus. Statistic shows increased hearing loss as the age grows.

62 (60.8%) males were suffering from HL and 33 (32.35%) were suffering from tinnitus while 25 (52.1%) females were suffering from HL and 12 (25%) were suffering from tinnitus. P value indicates no association between gender, hearing loss and tinnitus. This was calculated for test group only. Participants who were exposed for five hours suffered 28% from HL and 0% tinnitus, six hours 59% HL 23.1% more than six hours 66.3% HL and 41.9% tinnitus. P value (0.000) indicates strong relationship between noise Exposure per day, hearing loss and tinnitus. This was calculated for test group only. Participants who were exposed for two to three years suffered 31.4% from HL and 20.0% tinnitus, three to six years 68.4% HL and21.1% tinnitus, more than six years 64.9% HL and 39.0% tinnitus. P value (0.000) indicates strong relationship between noise Exposure per day, hearing loss and tinnitus.

In the low noise group 17.9% were suffering from HL and 0% from tinnitus, in the medium group 64.2% from HL and 26.4 from tinnitus, in the high group 69.6% participants were suffering from Hearing loss and 44.9% were suffering from tinnitus. The P value was .000 indicating a strong relationship between loudness of noise, hearing loss and tinnitus. 83(74.1%) participants who were not using HPD were all suffering from hearing loss while 35(43.2%) were suffering from tinnitus. P value was .000 indicating a strong occurrence of HL and tinnitus in the participants who were non user of HPD.

All the 23 participants who were using hand free were suffering from HL while 10 (43.5%) were suffering from

tinnitus. Nobody was suffering from HL in the group who were not using hand free while only 2 (7.4%) were suffering from tinnitus Out of the forty five tinnitus sufferers 39 (44.85%) were suffering from both hearing loss. The P value was 0.000 indicating a strong relationship between hearing loss and tinnitus. Out of 87 participants who were suffering from HL 84 (96.6%) was of bilateral while only three were suffering from unilateral hearing loss. 26 (29.9%) were suffering from mild hearing loss, 39 (44.8%) were moderate HL and 22 (25.3%) were suffering from severe HL while 4 (9.1%) were suffering from mild tinnitus,38 (86.4%) were moderate and 2 (4.5%) were suffering from severe tinnitus. Eighty two (94.4%) participants were suffering from high frequency hearing loss while 5 (5.7) were suffering from low frequency hearing loss.

Age Distribution	Frequency	Percent
15 to 20 Years	83	41.5
21 to 25 Years	36	18.0
26 to 30 years	26	13.0
31 to 35 Years	35	17.5
36 to 40 Years	20	10.0
Total	200	100.0

Table1: Age Wise Distribution of Participants

Gender	Frequency	Percent
Female	73	36.5
Male	127	63.5
Total	200	100.0

Table 2: Gender Wise Distribution of Participants

Outcome variables	Not exposed n=50	Exposed to noise				P value
		Total n=150	Industrial n=50	Traffic n=50	Music n=50	
Hearing loss	0 0%	87 58%	33 66.0%	31 62.0%	23 46.0%	.000
Tinnitus	0 0%	45 30%	17 34.0%	16 32.0%	12 24.0%	.000

Table 3: Association of Noise To Hl and Tinnitus

Outcome variables	Age groups					Total 150
	15 to 20 Years n=43	21 to 25 Years n=36	26 to 30 years n=26	31 to 35 Years n=29	36 to 40 Years n=16	
Hearing loss	19 44.2%	24 66.7%	15 57.7%	18 62.1%	11 68.8%	87 58%
Tinnitus	13 30.2%	9 25%	9 34.6%	8 27.6%	6 37.5%	45 30.0%

Table 4: Association of Age to Hl and Tinnitus

Outcome variables	Gender		Total n=150
	Male n=102	Female n=48	
Hearing Loss	62 60.8%	25 52.1%	87 58.0%
Tinnitus	33 32.35%	12 25%	45 30%

Table 5: Association of Gender with Hearing Loss and Tinnitus

Outcome variables	Noise exposure per day			Total n=150
	Five hours n=25	Six hours n=39	More than Six hours n=86	
Hearing loss	7 28.0%	23 59.0%	57 66.3%	87 58.0%
Tinnitus	0 0%	9 23.1%	36 41.9%	45 30.0%

Table 6: Association in Noise Exposure per Day, Hearing Loss and Tinnitus

Outcome variables	Noise Exposure Per Year			Total
	Two to three years n=35	Three to six Years n=38	more than six Years n=77	150
Hearing Loss	11 31.4%	26 68.4%	50 64.9%	87 58.0%
Tinnitus	7 20.0%	8 21.1%	30 39.0%	45 30.0%

Table 7: Association in Noise Exposure per Year, Hearing Loss and Tinnitus

Outcome variables	**Loudness of sound**			**Total** n=150
	Low	**Medium**	**High**	
Hearing loss	**5** 17.9%	**34** 64.2%	**48** 69.6%	**87** 58.0
Tinnitus	**0** 0%	**14** 26.4%	**31** 44.9%	**45** 30%

Table 8: Relationship between Loudness of Sound, Hearing Loss and Tinnitus

Outcome variables	Use of HPD		Total	P value
	Yes n=38	No n=112		
Hearing loss	**4** **10.5%**	83 74.1%	87 58.0%	
Tinnitus	**10** **14.5%**	**35** **43.2**	**45** **30.0%**	

Table 9: Association in Use of Hearing Protection Devices, Hearing Loss and Tinnitus

Outcome variables	Listening pattern		Total=50	P value
	Listening without Hand free n=27	Listening with Hand Free n=23		
Hearing Loss	0 0%	23 100%	23 46.0%	
Tinnitus	2 7.4%	10 43.5%	12 24.0%	

Table 8: Relationship between Listening Pattern Hearing Loss and Tinnitus

			Hearing Loss		
	Tinnitus		No	Yes	Total
	No		57	48	105
			54.3%	45.7%	100.0%
	Yes		6	39	45
			13.3%	86.7%	100.0%
Total			63	87	150
			42.0%	58.0%	100.0%

P Value=0.000

Table 9: Association between Tinnitus and Hearing Loss

Lateralization of Hearing Loss		Frequency	Percent
	Unilateral	3	3.4
	Bilateral	84	96.6
	Total	87	100.0

Table 10: Lateralization of Hearing Loss

Outcome variable	Intensity			Total
	Mild	Moderate	Severe	
Hearing loss	26 29.9%	39 44.8%	22 25.3%	87 100%
Tinnitus	4 9.1%	38 86.4%	2 4.5%	44 100%

Table 11: Intensity of Tinnitus and Hearing Loss in the Affected Participant

	Frequency of loss	Frequency	Percent
	Loss at Low Frequency	5	5.7
	Loss at High frequency	82	94.3
	Total	87	100.0

Table 12: Frequency of Loss

		Frequency	Percent
	4 kHz	71	78.9
	6 kHz	7	7.8
	8 kHz	7	7.8
	.75kHz	3	3.3
	.50kHz	1	1.1
	.25kHz	1	1.1
	Total	90	100.0

Discussion

This study was conducted to observe the hazardous effects of noise pollution on the hearing of young adults of Hyderabad district. Peoples are exposed to noise pollution by various ways so we studied the effects of noise pollution on participants exposed to various types of noise pollution. These include industrial noise, traffic noise and music noise. To obtain the effects of noise pollution on age and gender different age and gender groups were constructed. The effects of duration of exposure and intensity of noise on the hearing of participants were also noted. Two major outcomes were noted, hearing loss and tinnitus.

The present study concludes that persistent noise exposure produces Noise induced hearing loss (P value 0.000). Fifty eight percent (58%) of participants of this study were suffering from hearing loss. Ketabi D[27] conducted a similar research re on 245 workers of cutting and punching industry, 27.31% HL was reported in the study. The reduced ratio of HL was because of the better working conditions in the European factories and abidance of rules and regulations. Josef Shargorodsky et al 2010[28] reported hearing loss of 16.9% to 19.5% (P.02) in different groups. The main reason of reduce HL

was probably a large sample size, short range age group i.e. 12 to 19 years and good working conditions.

Suadicani P 2012[29] reported Forty seven (47.3%) HL in a similar kind of study conducted on 2996 peoples from different professions. In a similar type of study conducted by Mahindra Prasahanth 2011[2], 36% workers were suffering from NIHL the low incidence was because of a limited age group (16-25) and better working conditions. Singh L P 2010[30] reported 58% of HL which was quite similar to our study.

The present study concluded that the magnitude of noise induced hearing loss is directly proportional to the duration and intensity of exposed sound. This finding was similar to the findings of Ashraf H D et al[3], who reported 22.5%[3] HL which showed positive association between HL, duration of exposure and intensity of noise. Emara et al 2013[31] conducted a research on the workers of textile industries and forge industries, 62.2% HL was noted. HL showed the same trend regarding duration and intensity of noise.

The present study concludes that noise not only produces HL but also tinnitus and both are associated with each other. This finding was similar to the result reported by Shrista I et al 2011 who conducted research on traffic noise and reported 75 HL in males and 25.5% females. Tinnitus was 23.6%ly associated with HL. Santoni et al 2010[32] conducted a research on the music noise and reported 21.1% HL and 56.6% tinnitus. Both were closely associated with each other. The higher HL was because of very small sample size i.e. 23 male musician. Ratnayake S A B[33] 2012 concludes that tinnitus is actually produced by NIHL.

The present study concludes that NIHL usually occurs at high frequencies. This can be matched by a study con ducted by Hassan D et al[14] 2011 who reported 31% HL which was at high frequencies. Topila E[7] 2011 conducted a research on 67 musicians and he concluded the same result that noise produces hearing loss at higher frequency. Chagok 2013 N[34]

also conducted a research on 524 workers working in different noisy areas and found most of the HL at high frequency.

The present study showed no specific association between age and hearing loss. It also concludes that more hearing loss occurs in the older age group and non user of hearing protection devices (HPD). These results can be matched to study conducted by McCullagh et al[35] 2011, who found that hearing loss (19%) was more common among males of higher age group who were not using HPD. and prolonged length of profession and increased exposure of noise level. Rabinowitz P M[36] in 2007 noticed a decreased incidence of HL in workers who were using HPD. Michel F[37] 2013 conducted a similar kind of study on the manufacturing workers and reported 14% less HL in the users of HPD. A contradictory result was announced by Idota at al[38] 2010 who noticed more TTS in persons who were using HPD then those non users (.001). Most of the hearing loss was at high frequency level. This result was obtained because only pin ball industry workers were selected with an only 54 participants taking part in the study.

The present study concludes that age and tinnitus are not interrelated. Tinnitus which in most of the cases was associated with hearing loss. This observation can be compared to that of Fioretti et al[39] 2013 who found no correlation between tinnitus and age of participants. The P value was .006

The present study showed a close association between Music listeners and hearing loss (P value 0.000). This result can be compared to study conducted by Rawool V W[15] 2008, who discovered that loud music and noisy environment damages the hearing of the youth. (P value .0026). In the study conducted by Jansen E J et al[40] 2009 hearing status of symphony orchestra were measured 241 participants with an age range 23 to 64 years were measured. 17% showed NIHL.

The present study suggests that music listeners who use hand free device are at greater risk then the non users. A similar result was obtained by Kahari K R et al[41] 2011 who

found more hearing loss in the users of hand free devices (P value >0.000).

In the present study a close link was found between traffic noise and hearing loss (P value 0.000). Stansfeld et al[42] in 2009 conducted a research about the effect of traffic noise on the on the hearing and found 28% of HL.

Conclusion

Noise produce drastically adverse effects on the hearing of persons who are exposed to excessive level of noise on persistent bases. Hearing loss was not associated with age and sex but closely associated with loudness of sound and duration of exposure.

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