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A Study of Headphone Usage on Cognitive Constraints Between Genders

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Abstract: *Headphone usage is drastically increased nowadays with about 173 million users, especially among teenagers. The electromagnetic fields acquire importance due to symptoms like warmth, headache and fatigue. The purpose was to assess the possible deleterious effects of headphone usage on cognitive functions in both genders. The cognitive functions assessment was done using 60 undergraduate medical students between the age group of 18-21 yrs, using cognitive function tests like Mini mental status examination (MMSE), Wechsler Memory Scale (WMS-1&2), Letter Digit Substitution Test (LDST) and Digit Symbol Substitution Test (DSST). Scoring was done by using the scale. They were divided into 4 groups. Group 1: Headphone users < 1hr / day. Group 2: Headphone users > 1hr <2 hrs / day. Group 3: Headphone users 2-3hrs / day. Group 4: Headphone users >3hrs/ day. Data were compared by unpaired Student's t test and one-way ANOVA. There was a significant decrease in MMSE scores between groups 1 vs 4 and WMS 1 scores between 1vs 3 and 1 vs 4 in females. But in males, there was a significant decrease in DSST and MMSE scores between 1 vs 4. The WMS 1 scores were also significantly decreased between all the groups and WMS 2 scores between 1 vs 4. The results indicated that the cognitive impairment is more pronounced in males when compared to females and has a linear relation with duration of exposure.*

Keywords: *Cognitive functions, Gender difference, Head phone users, Mobile phones, Music.*

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I. Introduction

About 5.6 billion people use mobile phones worldwide. India ranks second position with about 885 million users [1]. Apart from its function of making calls, listening to music has become one of the popular functions, the sound delivered via headphones at high intensities. Headphone usage is drastically increased nowadays especially among teenagers The electromagnetic fields acquire importance due to symptoms like warmth, headache and fatigue [2]. Most of the students have the habit of listening to earphone music. This may lead to music-induced hearing loss [3]. Sound ≤85dB is considered safe. The threshold value is 85 dB, above which prolonged exposure to music for ≥ 8 hours causes permanent hearing loss.

Cognition is a higher brain function enabling the individual to experience the world by a complex process of interpretation and reinterpretation of sensory information like awareness, perception, reasoning and judgement. It includes evaluation, categorization and discrimination of stimulus and time required depends on the individual's cognitive ability. Initially electromagnetic waves stimulate the brain [4] but causes impairment on prolonged usage [5]. If a person is exposed to sounds >90dB for an average of 8 hours per day without hearing protection, hearing loss will most likely result [6]. Hearing evaluation [1], ear infection & hearing loss [7], hearing loss linked to accelerated brain tissue loss [8] in headphone users, hearing loss and cognition in older age [9,10] have been studied so far. The advantage of analyzing the above topic is to create awareness among the teenagers about the deleterious effects of loud noise and electromagnetic waves emitted by the headphones. As little information is available on the influence of prolonged headphone usage on cognitive functions, this study has been chosen to assess the possible deleterious effects of headphone usage on cognitive functions in both genders.

II. Materials And Methods

An observational study was conducted among 60 medical students aged between 18 and 21 years in the department of Physiology at Sri Venkateshwaraa Medical College Hospital and Research Centre in Puducherry, after obtaining Instituitional Ethical Committee (IEC) clearance before the commencement of study. After obtaining the prior consent from the subjects, they were divided into 4 groups. Group 1: Headphone users < 1hr / day. Group 2: Headphone users > 1hr <2 hrs / day. Group 3: Headphone users 2-3hrs / day. Group 4: Headphone users >3hrs/ day. The subjects were selected by convenient sampling method and the selection was based on the following criteria. The subjects with history of organic brain disease likely to reduce cognition, prolonged hospitalization likely to reduce attention span and history of systemic diseases like diabetes mellitus, hypertension, and presbycusis were excluded. Informed written consent was obtained from all the subjects prior to the study. An ID code was assigned for the subjects to maintain confidentiality of the data obtained.

2.1 Cognitive functions:

A total of 60 subjects with age group (18 – 21 years) were recruited and after measuring their anthropometrical parameters, the cognitive functions in headphone users were assessed. The following tests were used to assess the cognitive functions –

2.1.1 Mini Mental Status Examination (MMSE): It was done by asking a set of 11 questions under following section like orientation, registration, attention, calculation, recall and language. The questions are very basic like name of year, season, date, month etc. The total score was assessed and categorize the subject under category of whether she is alert/coma/stupor/drowsy [11].

2.1.2 Digit Symbol Substitution Test (DSST): The test was done to assess neuropsychological activity of brain. It consists of (eg. one digit – symbol pair, 1/-,7/^, 9/=) followed by a list of digits. Under each digit the subject should write down the corresponding symbol as fast as possible within 30 seconds. The number of correct symbols within the allowed time is measured and score awarded.

2.1.3. Letter Digit Substitution Test (LDST): The test was done to assess cognitive function. It consists of (eg nine letter), digit pairs eg (w/1, b/2, t/3, p/4, v/5 ……. j/9) followed by list of alphabets. Under each alphabet, the subject must be instructed to write down the corresponding digit within 60 seconds time period.

2.1.4. Wechsler Memory Scale – Revised (WMS-R): Two different tests were done in this type of cognitive function tests.

(a) Spatial addition sub test: It assesses visuo-spatial storage and manipulation in working memory. The examinee was shown a grid with blue or red dots on it for 5 seconds. They were asked to remember the location of the blue dots and ignore red dots that appear on page. The examinee was then shown a second page with blue and red dots for 5 seconds, examinee then adds the two visual images together. The examinee must place the blue dot in the grid in location where they saw blue dots on either page and white dot in location where blue dot appeared in common.

(b) Design sub test: The examinee was shown a page with designs placed in grid. There are 4 times having 4,6,6,8 designs for examinee to remember respectively. The examinee was asked to remember the designs and the location of designs. After seeing the stimulus page for 10 seconds, the examinee was given puzzle grid and cards with designs on them. The examinee must select the cards with correct designs and place them in puzzle grid in correct position. After 20-30 min of delay, the examinee was given the cards to place in the grid and scores are calculated.

III. Statistical Analysis Of Data:

The data were analyzed by using SPSS 17.0 software and expressed as mean ± standard deviation. Student's 't' test and one way ANOVA test were used to demonstrate the findings. The statistical probability of P< 0.05 was considered to be significant.

IV. Results:

Table 1: Comparison of anthropometric data between the genders

GROUPS		Mean ± SD			
		Age	Height	Weight	BMI
1	Males	19.4 ±1.65	158 ±0.02	54.9 ±4.53	21.9 ±2.19
	Females	19.47 ±1.63	159 ±0.06	54.93 ±4.49	21.92 ±2.15
	P value	0.86	0.41	0.14	0.37
2	Males	19±0	166.5 ±6.36	60 ±18.3	21.43 ±4.98
	Females	19±0	155 ±7.07	45 ±9.89	18.6 ±2.41
	P value	-	0.11	0.35	0.50
3	Males	19±0	160±0	51.5 ±4.94	20.24 ±1.76
	Females	19±0	158.5 ±6.36	54 ±8.48	21.41 ±1.65
	P value	-	0.60	0.59	0.34
4	Males	19±0	165.5 ±6.36	64 ±2.82	21.58 ±2.46
	Females	19±0	162 ±1.41	60 ±5.65	22.84 ±1.76
	P value	-	0.10	0.16	0.27

P<0.05 is statistically significant. SD: Standard Deviation, BMI: Body Mass Index.

The baseline characteristics of the subject were compared between the two genders of all the groups (Table-1). As evident from table 1, the males and females of all the groups did not differ across their demographics which indicate an effective randomization.

Table 2: Cognitive function tests in females

GROUPS	Mean ± SD				
	LDST	DSST	MMSE	WMS1	WMS2
1	37.85 ±5.25	38.85±5.00	25.45±2.80	5.30±0.98	3.30±1.26
2	34.5±6.36	31.5±4.95	24.50±2.12	4.50±0.71	1.50 ±0.71
3	33.50±7.33	35.50±7.85	22.90±2.85	3.00±1.83	1.75±0.96
4	38.50±4.60	40.60±6.72	22±2	3.30±1.95	2.10±1.37
1 Vs 2	0.40	0.12	0.50	0.20	0.29
1 Vs 3	0.54	0.33	0.22	0.04*	0.10
1 Vs 4	0.65	0.47	0.01*	0.01*	0.27

Data is expressed as mean ± SD. LDST: Letter Digit Substitution Test; DSST: Digit Symbol Substitution Test; MMSE: Mini Mental Status Examination; WMS 1: Wechsler Memory Scale 1; WMS 2: Wechsler Memory Scale 2; Statistical analysis was done by one-way ANOVA & unpaired t-test. P-value <0.05 was considered statistically significant.

Table 3: Cognitive function tests in males

	MEAN ± SD				
GROUPS	LDST	DSST	MMSE	WMS1	WMS2
1	41.00±4.78	42.20±5.12	28 ±1.70	5.70±0.67	3.90±0.74
2	37.00±3.92	39.60±8.29	27±1.41	3.25±1.50	3.00±1.00
3	43.20±3.27	36.40±5.27	23.80±1.64	3.20±1.48	2.75±0.96
4	35.80±5.63	29.00±8.52	23.00±2.55	3.20±1.48	2.00±0.71
1 Vs 2	0.40	0.72	0.39	0.03*	0.24
1 Vs 3	0.49	0.19	0.03	0.01*	0.09
1 Vs 4	0.37	0.05*	0.02*	0.01*	0.001*

Data is expressed as mean ± SD. LDST: Letter Digit Substitution Test; DSST: Digit Symbol Substitution Test; MMSE: Mini Mental Status Examination; WMS 1: Wechsler Memory Scale 1; WMS 2: Wechsler Memory Scale 2; Statistical analysis was done by one-way ANOVA & unpaired t-test. P-value <0.05 was considered statistically significant.

V. Discussion

The mobile phones have become indispensable as communication tools; however there is only limited information exists about the interaction between headphone usage and cognitive functions. Studies showed that chronic exposure to sound more than 90 dB can result in permanent hearing loss [12] an MP3 player can effectively produce a sound of 120 dB, which is further amplified as much as 6-9 dB, while it is being used with an earphone. Thus, listening to louder sounds over long term produce hearing loss. The cell phone music has become one of the most common devices for listening to music in adults and teens. The students very often put on their ear phone and listen to music whenever they get time and usage has become more rampant.

In our study, the scores of cognitive function tests decreased significantly in all the groups and more pronounced in groups who listened to music for a longer period of time. In a study conducted by Granick et al [13], the results revealed substantial association between hearing loss and scores achieved on the intellectual measures and emphasized that hearing is an important variable to be considered in the assessment of their cognitive functioning. Further the association between cognition and hearing impairment was emphasized by Lin and his colleagues [14] where older adults with hearing impairment would have a 24% increased risk for decline in cognitive function over time and may experience a 30- 40% faster decline than those without a hearing loss. Similar findings were reported by Wingfield and Tun [15] that those with a mild to moderate hearing loss had greater difficulties with recall, which took away the resources available for storing information in working memory.

Tay et al [16] also found that among adults of 50 years of age and over, those with a moderate to severe hearing loss exhibited slightly poorer Mini Mental State Examination (MMSE) score than those with normal hearing. Results from Lindenberger and Baltes [17] and Schneider et al [18] concur with this finding. The above studies support the findings of our study where the cognition seemed to be decreased significantly between the groups. In a study conducted by Koh da [19], as elderly individuals get older, their hearing and cognition as well as their balance abilities deteriorate showing a significant correlation between hearing loss and static balance.

In a study by Latha et al, the scores of cognitive function tests decreased significantly in headphone users who listened to music for a longer period [20]. In a study by Schoeni [21] on the symptoms and the cognitive functions in adolescents in relation to mobile phone use during night, the memory and the concentration capacity were not related to mobile phone use during night. It was associated only with tiredness, rapid exhaustibility, headache and physical ill-being, but not with memory and concentration capacity. In a study by Nittby et al [22], there is a clear evidence that long term cell phone exposure poses a risk to healthy cognitive function. Hearing loss is often thought of as a natural byproduct of aging process. However, studies are beginning to show that hearing loss is becoming increasingly more common amongst younger people, which is due to chronic exposure to loud noise above 90 dB, according to the National Institute on Deafness and other Communication Disorders. Additionally the use of ear buds (earphones) placed directly into the ear can amplify the sound signal by as much as 6-9 dB.

VI. Conclusion

In our study, the cognitive function test scores have been significantly decreased as the duration of exposure is increased and the cognitive impairment is more pronounced in males when compared to females. The enhanced sound quality, convenience and portability translate into more time spent listening to music and consequently increased the potential for hearing loss.

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