Original article

Music listening habits of adolescents in a South Indian city

Usha Shastri[1], Gudambe Nellithaya Spoorthi[2], Sharel Lopes[3], Mohan Kumar Kalaiah[4]

Abstract:

Objective: Universal access to personal music listening devices has attracted many adolescents to listen to music. However, risky music listening behavior can lead to music-induced hearing loss, becoming a major social and public health problem. We aimed to investigate music listening habits in three groups of adolescents based on age, learn the differences in music listening habits among the groups, if any, and assess their knowledge regarding loud music-induced hearing loss. ***Materials and method*:** A total of 300 adolescents aged 13-20 years studying in various schools and colleges of a South Indian city completed a questionnaire to understand music listening habits and knowledge regarding loud music-induced hearing loss. Based on age and education level, they were divided into three groups of 100 each [high school(HS): 13-16 years, pre-university(PU): 16-17 years, and undergraduate(UG) level: 18-20 years]. ***Results:*** Duration and frequency of music listening, usage of the device, and accessory were similar among the three groups. However, across the age, there is a difference in the loudness in music listening (younger HS and PU groups frequently used loud volume) and the awareness about the damage caused to hearing due to loud music (younger HS group was least aware). A reduced hearing was reported by 17% of the UG group as opposed to 4% of the HS group. ***Conclusion:*** With the use of earphones and loud volume, younger adolescents are at greater risk for music-induced hearing loss than older adolescents. This group, if educated, is ready to accept modifications in listening behaviors that are hearing protective.

Keywords: Adolescents across age; Indian adolescents; music-induced hearing loss; music listening habits; personal music system; changes in hearing

Bangladesh Journal of Medical Science Vol. 22 No. 04 October'23 Page : 882-894
DOI: https://doi.org/10.3329/bjms.v22i4.67128

Introduction:

Music is a form of art and cultural activity. It plays a vital role in the lives of adolescents and young adults in modern society.[1, 2] The period of transition from childhood to adulthood is called adolescence.[3] The music serves as a tool to overcome various developmental challenges and complex issues an adolescent goes through.[1]

Various popularized personal music systems in the present time have made a large number of people listen to loud music for an increased duration. Adolescents who are frequent listeners of music

1. Usha Shastri,Department of Audiology and Speech Language Pathology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal Karnataka, India shastri.usha@gmail.com. orcid id: 0000-0003-1172-3549
2. Gudambe Nellithaya Spoorthi, Nitte Institute of Speech and Hearing, Deralakatte, Mangalore, Karnataka, India. Email: spoorthign97@gmail.com
3. Sharel Lopes, Nitte Institute of Speech and Hearing, Deralakatte, Mangalore, Karnataka, India. sharellopez123@gmail.com
4. Mohan Kumar Kalaiah, Department of Audiology and Speech Language Pathology, Kasturba Medical College, Mangalore, Manipal Academy of Higher Education, Manipal, Karnataka, India. kmohankumar18@gmail.comorcid id: 0000-0001-9984-9175.ResearcherID: B-2304-2016

Correspondence: Mohan Kumar Kalaiah**,**M.Sc (Audiology), PhDAssociate Professor Department of Audiology and Speech Language Pathology**,** Kasturba Medical College, Mangalore**,** Manipal Academy of Higher Education, Manipal**,** Karnataka, India – 575001**.** e-mail: kmohankumar18@gmail.com

tend to listen to music at high levels, damaging their hearing.[4] Listeners who habitually exceed seven hours of music listening per week at average intensities between 70 and 80 dB (A) are at risk of developing permanent music-induced hearing loss.[5] Hellstrom et al. [6] reported a temporary threshold shift one hour after exposure in young individuals who regularly use their personal music players for an average of 3 hours/day at an average of 92 dBA. Regardless of this risk, adolescents are either not aware of the damage caused due to loud music or do not consider themselves at danger to suffer music-induced hearing loss.[7] Due to this attitude, they continue to enjoy music at greater intensities for longer durations, putting them at a higher risk of developing hearing loss.

In a longitudinal study to track the recreational habits and auditory function of adolescents who are exposed to loud music, the authors showed that continuous exposure to loud music leads to a gradual shift in the hearing threshold in a 3-year interval.[8] Another study reported only 14% of the adolescent and adult participants use hearing protection devices at places where loud music was being played.[9] Also, only 8% [9] and 13% [10] of the adolescent participants thought hearing loss 'a very big problem.' Thus, hearing loss has received less priority among adolescents and young adults than other health-related issues (e.g., depression, alcohol and drug use, smoking). These attitudes are challenges to promote hearing health among adolescents.

Vogel et al. [7] analyzed the responses from adolescents pursuing pre-vocational and pre-university education in the Netherlands. Their findings showed that different groups of adolescents may show different listening behaviors and attitudes towards music-induced hearing loss. Studies have also confirmed that a significant proportion of the adolescents and adults listen to music with exposure to ≥ 75 dBA, which is a high risk for music-induced hearing loss.[11,12]

Understanding people's music listening habits during the adolescent period has received little attention among the Indian population. Kumar and Deepashree [12] had Indian adolescents and young adults (15-30 years) in their study group. Hence, the music listening behaviors of only adolescents were not focused. According to the World Health Organization (WHO), any person aged between 10 to 19 years is considered an adolescent. Adolescence forms a broad age group; therefore, music listening habits could vary with age among adolescents. Besides, exposure to loud music is associated with age and educational level.[13] These changes can also affect the susceptibility for music-induced hearing loss. To the best of our knowledge, studies have not investigated the changes in the music listening habits of adolescents across age. Therefore, the objective of the present study was to investigate whether the music listening habits of adolescents varied across age. Hence, we investigated music listening habits in high school (HS) (age:13-16 years), pre-university (PU) (age:16-17 years), and undergraduate (UG) students (age:18-20 years). Besides, their knowledge and perception about music-induced hearing loss were also assessed using a questionnaire-based approach.

Materials and method:

Questionnaire

A questionnaire on Personal Music Listening System Usage (Q-PMSU) [12] was used to collect information regarding music listening habits and awareness of music-induced hearing loss. It consists of 22 questions in four parts: the first part collects information about the device and accessories used to listen to music, the second part collects information regarding music listening habits, the third part has questions about the hearing status after continuously listening to music, and the fourth part consists of questions about the participants' awareness regarding damage to the hearing due to loud music exposure. Apart from this, questions were also asked regarding changes in music listening behavior over the years, acquaintance with family members who listen to music, and reasons for listening to music. The first and third parts have close-set questions with multiple choices but have options to provide any other answer apart from the choices given for each question. The second and fourth parts have both open-ended and close-set questions. Ethical approval was obtained from the institutional ethics committee before the study.

Participants

A total of 300 adolescents, divided into three groups of 100 each, participated. The first group, labeled HS (age: 13-16 years; mean: 14.56 years, SD=0.61; 58 males), was studying at high school. The second group labeled PU (age: 16-17 years; mean: 16.83 years, SD=0.38; 66 males) studied at pre-university college. The third group, labeled UG (age: 18-20 years; mean: 19.23 years, SD=0.51; 19 males), was

pursuing undergraduate education. Permission was obtained from the school authorities to conduct the survey, and informed consent was obtained from the participants before distributing the questionnaire. The questionnaire was distributed in the classroom by the second and third authors. Instructions were provided to fill the questionnaire, and each question was explained to participants. Response to each closed-set question was tabulated, and data were subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS, version 16, SPSS Inc., Chicago, IL, USA).

Ethical clearence: Ethical clearance was obtained from the institutional ethical committee with the number NISH/SCICOM/2017-18/01_

Results:

Table 1: ***Device and accessories used to listen to music*** *Frequency of responses for the device used, accessories used, and type of music the participants listen, and Chi-square values of association of different responses between three groups*

Parameter		HS	PU	UG	χ^2 (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Device	Mobile	90	93	82	6.28	0.043*	0.145
	MP3 Player	17	14	17	0.45	0.800	0.039
	i-pod	4	10	2	6.87	0.032*	0.151
	Personal Computer/TV	31	40	13	20.42	0.000*	0.261
Accessories	Earphones	76	73	78	0.69	0.709	0.048
	Headphones	35	22	11	16.47	0.000*	0.234
	Speakers	33	35	18	8.44	0.015*	0.168
Type of music	Pop	34	33	7	25.22	0.000*	0.290
	Rock	43	57	24	22.63	0.000*	0.275
	Semi classical	51	63	61	3.40	0.180	0.106
	Classical	30	28	25	0.63	0.730	0.046

Note: * p significant at 0.05. HS – High School group , PU – Pre University group, UG - Undergraduate group

Table 1 shows the frequency of responses for the device and accessory used and the type of music the participants listen to. Participants could choose more than one option for these questions. The majority of participants in all three groups listened to music using mobile (82-93%) with earphones (73-78%). To further analyze the data, the Chi-square test of association was carried out to check for a significant association between responses to each question and groups. Cramer's V was reported as the effect size measure (Table 1). Wherever significant association was observed, a pair-wise Chi-square test with Bonferroni's correction ($p<0.017$) for multiple comparisons was made to understand the results better, which is reported in Table 2.

Table 2. *Pairwise Chi-square comparison among three groups for the device used, accessories used, and type of music the participants listen*

Parameter		Group	χ2(1) N=200	Significance (p value)	Effect size (Phi)
Device	Mobile	HS vs. PU	0.58	0.447	0.054
		HS vs UG	2.66	0.103	-0.115
		PU vs. UG	5.53	0.019	-0.116
	iPod	HS vs. PU	2.77	0.096	0.118
		HS vs. UG	-+	-+	-+
		PU vs. UG	5.67	0.017*	-0.168
	Personal computer/ TV	HS vs PU	1.77	0.184	0.094
		HS vs UG	10.69	0.001*	-0.231
		PU vs UG	20.37	0.000*	-0.319
Accessories	Headphones	HS vs PU	4.15	0.042	-0.144
		HS vs UG	16.26	0.000*	-0.285
		PU vs UG	4.39	0.036	-0.148
	Speakers	HS vs PU	0.09	0.765	0.021
		HS vs UG	5.92	0.015*	-0.172
		PU vs UG	7.42	0.006*	-0.193
Type of music	Pop	HS vs PU	0.02	0.881	-0.011
		HS vs UG	22.37	0.000*	-0.334
		PU vs UG	21.13	0.000*	-0.325
	Rock	HS vs PU	3.92	0.048	0.140
		HS vs UG	8.10	0.004*	-0.201
		PU vs UG	22.60	0.000*	-0.336

Note: HS-High school group; PU-Pre-university group; UG-Undergraduate group; * p significant at 0.017 (Bonferroni's correction for multiple comparisons); + Chi-square analysis not done as more than 20% of the cells had expected cell frequency less than 5.

The effect size measure for pair-wise comparisons was Phi. From table 1, it can be noted that there was a significant association between specific devices (mobile, iPod, and personal computer/TV) and groups. Mobile phones were the most commonly used device by all three groups (82-93%), and no significant association was found with any group during pair-wise analysis (Table 2). Among other devices, the pair-wise analysis showed that the PU group more likely used iPods than the UG group. Similarly, the HS and PU groups were more likely to use personal computers or TV to listen to music than the UG group.

Among accessories, earphones were equally used by all the groups (Table 1). From table 2, it can be observed that headphones were significantly more associated with the HS group as opposed to the UG group. UGs less likely to use speakers to listen to music compared to HS and PU groups. All three groups majorly listened to the semi-classical type of music (table 1). Among other types of music, UGs were significantly less likely to listen to pop and rock music, while the PU group was more likely to listen to rock music (Table 2).

Music listening habits

Duration of music listening was recorded in

minutes. This data was available from 83, 87, and 80 participants in HS, PU, and UG groups, respectively. Other participants had mentioned that the duration of music listening would vary depending on their mood, free time, etc. The mean duration of music listening per day was 76.27 minutes (SD=65.04; range=5-270 minutes), 81.56 minutes (SD=75.71; range=10-380 minutes), and 87.23 minutes (SD=77.36; range=5-380 minutes), for HS, PU, and UG group respectively. It can be observed that as age and education level increased, the mean duration of music listening also increased. To assess if this duration difference was significant across the groups, one-way ANOVA was administered with the duration of music listening as the dependent factor and groups as between-subject factors. Results revealed no significant main effect of group on music listening duration [$F(2,247)=0.460$, $p=0.63$]. The median music listening duration was 60 minutes across all the groups.

Table 3 reports the frequency of music listening, the loudness of listening, and whether the device provides a warning signal when the loudness is more. For the purpose of statistical analysis, the frequency was dichotomized as 'daily listening' vs. 'non-daily listening.' Most of the participants in all three groups listened to music every day (59-65%). The frequency of music listening and group was not significantly associated with groups.

Participants subjectively rated the loudness at which they listen to the music on a 5-point rating scale (very soft, soft, medium, loud, very loud). The majority of participants listened to music at a medium level (60-65%). These five categories were collapsed into two for statistical analysis: soft (including very soft, soft, and medium ratings) and loud (including loud and very loud ratings). Chi-square analysis showed a significant association between the loudness of music listening and group (table 3).

Table 3. *Frequency of responses for different music listening behaviors, and Chi-square values of association of different responses between three groups*

Parameter		HS	PU	UG	$\chi 2$ (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Frequency of listening to music	Daily	59	60	65	4.54	0.103	0.054
Loudness of music listening	Very soft/soft/medium	67	75	88	12.56	0.002*	0.205
Music system gives warning signal when volume is high	Yes	95	93	87	4.66	0.097	0.125
Action taken when the device provides warning signal	Never listen till warning level	24	18	25	1.65	0.438	0.074
	Reduce the volume	41	23	33	7.44	0.024*	0.157
	Reduce the volume slightly	18	30	13	9.43	0.009*	0.177
	Do nothing	14	19	15	1.04	0.594	0.059
Listening with one earphone	Never/ Sometimes	92	88	93	1.71	0.425	0.075
Music listening situation	Quiet	81	75	78	1.05	0.592	0.059
	Noise	29	32	19	4.74	0.094	0.126

Note: * p significant at 0.05; HS – High School group , PU – Pre University group, UG - Undergraduate group

The UG participants were significantly more likely to listen to music at soft loudness than HS participants (Table 4).

Table 4. *Pair wise Chi-square comparison among three groups for different music listening behaviors*

Parameter		Group	$\chi2(1)$ N=200	Significance (p value)	Effect size (Phi)
Loudness of music listening	Very soft/soft/medium	HS vs PU	1.55	0.213	-0.088
		HS vs UG	12.65	0.000*	-0.251
		PU vs UG	5.60	0.018	-0.167
Action taken when device provides warning signal	Reduce the volume	HS vs PU	7.45	0.006*	-0.193
		HS vs UG	1.37	0.241	-0.083
		PU vs UG	2.48	0.115	0.111
	Reduce the volume slightly	HS vs PU	7.69	0.047	0.140
		HS vs UG	0.95	0.329	-0.069
		PU vs UG	8.56	0.003*	-0.207

Note: HS-High school group; PU-Pre-university group; UG-Undergraduate group; * p significant at 0.017 (Bonferroni's correction for multiple comparisons

A greater proportion of the participants in all the three groups reported that their devices provided a warning signal when the volume was turned above the safe listening levels (87-95%) (Table 3). Table 3 also shows the action taken by the participants when the device provided a warning signal; a significant association was observed between groups and the action of reducing the volume or reducing the volume slightly. Pair-wise analysis (Table 4) revealed that the HS group was significantly more likely to reduce the volume than the PU group. Also, the PU group was significantly likely to reduce the volume slightly than the UG group. All the groups had a greater number of participants (88-93%) who never listened to music with one earphone, or sometimes only (Table 3). A majority of the participants in all three groups listened to music in a quiet situation (75-81%), and fewer participants listened to music in a noisy situation (19-32%). All these variables did not show a significant association with the groups.

Hearing status

Table 5. *Frequency of responses for the hearing status (sensation after listening to music, change in hearing, listening at higher volume, and listening difficulty) and Chi-square values of association of different responses between three groups*

Parameter		HS	PU	UG	$\chi2$ (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Sensations after listening to music for long duration	No such sensation	64	73	51	10.46	0.005*	0.187
	Blockage	6	0	2	7.19	-+	-
	Ringing sensation	9	8	12	0.99	0.609	0.058
	Intolerance to loud sounds	1	2	0	2.02	-+	-
	Pain	8	1	9	6.74	0.034*	0.150
	Irritation	8	5	12	3.23	0.199	0.104
	Headache	8	11	17	1.58	0.453	0.073
Change in hearing since the time they started music listening	Reduced	4	10	17	9.14	0.010*	0.175
	Reduces for few minutes after listening to music	13	16	20	1.81	0.406	0.078
	No change	81	74	61	10.22	0.006*	0.185

Parameter		HS	PU	UG	$\chi 2$ (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Listening at higher volume compared to when they started music listening	Yes	40	43	36	1.03	0.597	0.059
Listening difficulty	No difficulty	65	62	40	15.10	0.001	0.224

Note: * p significant at 0.05, $^{+}$ - Chi-square analysis not done as more than 20% of the cells contained expected cell frequency less than 5.; HS – High School group , PU – Pre University group, UG - Undergraduate group

Table 5 shows that among different sensations perceived after listening to music for a long duration, 'no such sensation' and 'pain' showed significant association with groups. Pair-wise analysis showed that the UG group was significantly less likely to report 'no such sensation' after listening to music for a longer duration than the PU group (Table 6).

Table 6. *Pair wise Chi-square comparison among three groups for the hearing status*

Parameter		Group	$\chi 2(1)$ N=200	Significance (p value)	Effect size (Phi)
Sensations after listening to music for long duration	No such sensation	HS vs PU	1.88	0.171	0.097
		HS vs UG	3.46	0.063	-0.131
		PU vs UG	10.27	0.001*	-0.227
	Pain	HS vs PU	5.70	0.017*	-0.169
		HS vs UG	0.964	0.800	0.018
		PU vs UG	6.74	0.009*	0.184
Change in hearing status	Reduced	HS vs PU	2.77	0.096	0.118
		HS vs UG	8.99	0.003*	0.212
		PU vs UG	2.10	0.147	0.102
	No change	HS vs PU	1.41	0.236	-0.084
		HS vs UG	9.71	0.002*	-0.220
		PU vs UG	3.85	0.050	-0.139
Listening difficulties	No difficulty	HS vs PU	0.19	0.659	-0.031
		HS vs UG	12.53	0.000	-0.250
		PU vs UG	9.68	0.002	-0.220

Note: HS-High school group; PU-Pre-university group; UG-Undergraduate group; * p significant at 0.017 (Bonferroni's correction for multiple comparisons)

The 'pain' was significantly more likely felt by HS and UG group than the PU group (Table 6). Regarding the change in hearing that the participants noticed since the time they started music listening, 'reduced hearing' and 'no change' showed significant association with groups (Table 5). Further analysis revealed that the UG group significantly more likely complained of reduced hearing as compared to the HS group. In contrast, the HS group was significantly more likely to report 'no change in hearing status' than the UG group (Table 6).

The number of participants who felt they are listening at a higher volume compared to the day they started listening to music across three groups was similar (36-43%) (Table 5). Participants also reported whether they have any difficulty in specific listening situations (e.g., telephonic conversation, social gathering, listening from a distance, listening in traffic) or not. From table 5, it can be observed that there was a significant association between the listening difficulties and group. Post-hoc analysis (table 6) showed that UG group (40%) were significantly less likely to report 'no difficulty' in different listening situations compared to both HS (65%) and PU (62%) group.

Awareness about loud music-induced hearing loss

Table 7. *Frequency of responses for awareness about loud music-induced hearing loss (damage to hearing, willingness to reduce volume, and willingness to reduce music listening time) and Chi-square values of association of different responses between three groups*

Parameter		HS	PU	UG	χ^2 (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Awareness about damage to hearing	Yes, definitely	46	63	58	6.19	0.045*	0.144
	Not sure	26	22	16	3.02	0.221	0.100
	No, it does not effect	4	9	9	2.45	0.293	0.090
	Don't know	21	4	10	14.43	0.001*	0.219
Willingness to turn the volume down	Yes	85	76	71	5.74	0.057	0.138
Willingness to reduce music listening time	Yes	68	49	57	7.47	0.024*	0.158

Note: * p significant at 0.05; HS – High School group , PU – Pre University group, UG - Undergraduate group

Table 7 shows that when awareness about damage to hearing due to loud music was noted, the responses 'definitely yes, it damages hearing' and 'don't know' showed significant association with the groups. Further, it was noticed that the PU group was significantly more likely to know that loud music can damage hearing than the HS group. In contrast, the HS group had a significantly greater proportion of people who did not know about it than the PU group (Table 8). There were 16-26% of the participants from three groups who were 'not sure' about it. About 4-9% of the people in the three groups thought that loud music does not affect their hearing. All three groups were equally ready (71-85%) to turn the volume down to listen to safer levels to prevent damage to hearing (Table 7). However, only the HS group (68%) had a significantly greater proportion of participants who were willing to reduce music listening time than the PU group (49%) to prevent hearing damage (Table 8).

Table 8. *Pair wise Chi-square comparison among three groups regarding awareness about loud music-induced hearing loss*

Parameter		Group	χ2(1) N=200	Significance (p value)	Effect size (Phi)
Damage to hearing	Yes, definitely	HS vs PU	5.83	0.016*	0.171
		HS vs UG	2.89	0.089	0.120
		PU vs UG	0.52	0.470	-0.051
	Don't know	HS vs PU	13.21	0.000*	-0.257
		HS vs UG	4.62	0.032	-0.152
		PU vs UG	2.77	0.096	0.118
Willingness to reduce music listening time	Yes	HS vs PU	7.44	0.006*	-0.193
		HS vs UG	2.58	0.108	-0.114
		PU vs UG	1.29	0.257	0.080

Note: HS-High school group; PU-Pre-university group; UG-Undergraduate group; * p significant at 0.017 (Bonferroni's correction for multiple comparisons)

Reasons for music listening

Table 9. *Frequency of responses for reasons for music listening (family members music listening and reasons for music listening) and Chi-square values of association of different responses between three groups*

Parameter		HS	PU	UG	χ2 (df = 2; N = 300)	Significance (p value)	Effect size (Cramer's V)
Family members listening to music	Yes	93	89	86	2.59	0.274	0.093
Reasons to listen to music	Enjoy the music	59	71	66	3.21	0.201	0.103
	Be trendy/cool	31	18	9	15.69	0.000*	0.229
	Create an image for yourself	18	17	5	9.06	0.011*	0.174
	While studying	10	6	4	3.00	0.223	0.100
	Relive boredom	29	30	12	11.33	0.003*	0.194
	Relieve tension/ stress	49	39	42	2.15	0.342	0.085
	Reduce loneliness	37	27	34	2.39	0.302	0.089
	While doing school/ college assignment	23	15	8	8.68	0.013*	0.170
	Others	8	0	0	16.44	-+	-

Note: * p significant at 0.05; + Chi-square analysis not done as more than 20% of the cells had expected cell frequency less than 5.; HS – High School group , PU – Pre University group, UG - Undergraduate group

Table 9 shows that most of the participants of all the three groups had their family members who listen to music (86-93%). The primary reason to listen to music was that they 'enjoy music' (59-71%).

Table 10. *Pair wise Chi-square comparison among three groups regarding the reasons for music listening*

Parameter		Group	χ2(1) N=200	Significance (p value)	Effect size (Phi)
Reason to listen music	Be trendy/cool	HS vs PU	4.57	0.033	-0.151
		HS vs UG	15.13	0.000*	-0.275
		PU vs UG	3.47	0.063	-0.132
	Create an image for yourself	HS vs PU	0.04	0.852	-0.013
		HS vs UG	8.30	0.004*	-0.204
		PU vs UG	7.35	0.007*	-0.192
	Relieve boredom	HS vs PU	0.02	0.877	0.011
		HS vs UG	8.66	0.003*	0.211
		PU vs UG	9.77	0.002*	0.221
	While doing school/college assignment	HS vs PU	2.08	0.149	-0.102
		HS vs UG	8.59	0.003*	-0.207
		PU vs UG	2.41	0.121	-0.110

Note: HS-High school group; PU-Pre-university group; UG-Undergraduate group; * p significant at 0.017 (Bonferroni's

Among other reasons, 'trendy,' 'creates an image for self,' 'relieves boredom,' and 'while doing school/ college assignment' were the reasons which showed significant association with the groups. Post-hoc analysis (Table 10) revealed that a significantly larger proportion of the HS group felt that listening to music is 'trendy' and significantly more likely to listen to music 'while doing academic assignments than the UG group. Besides, HS and PU groups significantly felt that listening to music 'creates an image for themselves and 'relieves boredom' compared to the UG group.

Discussion:

The present study investigated the music listening habits of adolescents from a South Indian city. Their knowledge about the loud music-induced hearing loss was also assessed. This is the first study that reports the music listening behaviors and knowledge about loud music-induced hearing loss across age among adolescents to the best of our knowledge. We observed that adolescents in the three age groups within the range of 13 to 20 years were similar in certain aspects and different in certain other aspects.

Device and accessories used to listen to music

In the present study, the device and accessory used for music listening were similar across three groups of adolescents differing in age. Mobiles phones were the frequently used device (82-93%) to listen to music. This indicates the universal accessibility of mobile phones to listen to music among the younger generation starting at least as young as 13-year-old of the HS group in our study population. This was similar to that of Sulaiman et al. , who also reported mobile as the frequently used device (51%) for music listening among their adolescent participants. However, we can notice that the frequency of mobile phone use is much greater in our study than in Sulaiman et al. [11]. This can also reflect the timeline when both the studies are done.

The frequently used accessory for music listening was earphones and was similar across the groups. This finding is similar to Kim et al. [14], where earphones were the most commonly used accessory, followed by headphones and speakers. When the outputs of earphones and headphones were compared, Fligor and Cox [15] found that the output intensities of earphones are 7-9 dB higher. Also, most earphone users, compared to speakers, tend to increase the volume to cope with the surrounding noises. These results indicate that the users of earphones or headphones are at a higher risk for developing hearing loss when compared to speakers.[14] Kim et al. [14] also compared the thresholds of users of different accessories and found that the users of speakers had significantly better thresholds compared to users of earphones and headphones. Nevertheless, when the thresholds of users of earphones and headphones

are compared, the users of headphones had better thresholds than earphones, though it was not statistically significant. From these investigations we can infer that the present study participants who primarily use earphones are possibly at higher risk for loud music-induced hearing loss.

Music listening habits

Though the median music listening duration of 60 minutes was similar across groups, the mean duration of music listening slightly increased with age. However, there were no statistically significant differences in the mean duration of music listening across groups. This result could be because of the large standard deviation obtained for each of the groups. Duration of music listening varied across the study population, with an average of 1.2 hours/day [11] to 21 hours/week [16]. Other studies have reported music listening duration of 2.45 hours per day [17] and one to three hours per day.[14] Music listening duration in our study is very similar to that found by Sulaiman et al. [11]. Furthermore, Jiang et al. [18], in their systematic review, noted that up to 58.2% of adolescents and young adults exceed their 100% daily noise dosage, especially in the presence of background noise.

A trend was observed across the groups in loudness at which the music is listened to. As the age increased, the number of participants who listen to music at a softer volume increased. The UG group had a significantly greater proportion of participants who listened to music at softer levels than the HS group. Thus, it appears that the younger adolescents have riskier music listening behaviors than older adolescents. Many adolescents engage themselves in risky music listening behavior, potentially damaging their hearing.[4,10,19] Our findings support the findings from the literature.

Our findings show that most of the current mobile phones provide a warning signal when the volume is increased beyond the safety level. This is a good sign for hearing conservation from the manufacturer's side. Despite this, a significant proportion of the adolescents did nothing when the device provided a warning signal (14-19%). This attitude is a cause of concern to the hearing conservation programs. It can be recalled here that only 46 to 63% of the present study participants are definitely aware of the damage to hearing caused by loud music. Thus, lack of awareness regarding music-induced hearing loss, in addition to the attitude that hearing loss is not a big problem [9,10,] might be the reason for such behaviors. Hearing loss is an invisible problem, and adolescents may not appreciate the magnitude of hearing loss on their quality of life in the long run. This highlights the need to create awareness programs to listen to music at safe levels, especially as early as 13 years in the HS age group.

Hearing status

Though the younger group had riskier music listening behavior, they majorly reported no changes in their hearing as well as no sensations related to hearing after listening to music. This could be because the younger group had lesser years of music listening habits than the older group. However, we did not measure the actual threshold of the participants to support this observation. Kim et al. [14] found elevated thresholds at 4kHz in adolescents who listened to music through personal music players for more than five years. This indicates that increased use of personal music players for the long-term can affect the hearing thresholds.

Awareness about loud music-induced hearing loss

A trend was observed across age regarding awareness about loud music-induced hearing loss. The younger HS group was less likely to be aware of the damage caused to hearing due to loud music compared to the older HS group. Lack of awareness in younger adolescents adds to more threat to the hearing health of this age group. However, the brighter side is that, the younger group was quickly agreeable to reduce the music listening duration to prevent damage to hearing than the older group. Besides, all three groups were willing to reduce the volume of music if it is causing damage to hearing. Studies on populations belonging to various races [7,16.20] also suggest that majority of the adolescent population is not aware that listening to loud music can damage their hearing.[10] Thus, our study supports these earlier findings that even for Indian adolescents, music is essential; they also indulge in risky music-listening behaviors, and many are unaware that loud music can cause hearing loss. That is, cultural differences have not affected the risky music-listening behaviors of adolescents.

Reasons for music listening

The younger HS group thought listening to music makes them trendy/cool, creates an image for themselves, and relieves boredom. This shows that the younger group has more emotional benefits from listening to music than the older group. Thus, the reasons for listening to music change as the function

of age and more likely with the psychological development associated with that age. Gantz et al. [21] reported that the reasons to listen to music among American adolescents included: relieving tensions, a distraction from worries, passing the time, and relieving boredom. Similar results were also reported by Adriano and DiPaola [22] among American adolescents. The most frequently agreed reasons for listening to music included: enjoying the music, relieving boredom, relieving stress, help them get through difficult times, and to be creative. Thus, even across cultures, the reasons for music listening are similar. In addition, investigations have shown that irrespective of ethnicities, different sounds can result in altered physiological measures. [23]

Limitations

This study has a few limitations. First, this is a cross-sectional study across age groups. Hence, the differences in risky music-listening behaviors, knowledge about music-induced hearing loss, and other factors may or may not reflect the longitudinal changes happening in adolescents as age advances. Second, the hearing evaluation was not done for participants in this study. Measurement of hearing thresholds would have confirmed whether the perception of 'no change in hearing status' or the perception of 'reduced hearing' is accurate. Hence, future studies can be done with a longitudinal design across age, measuring the output from personal music listening devices and measurement of the participants' hearing threshold.

We did not measure the actual output from participants' personal music listening devices at the volume setting, which they usually use. This would have provided evidence for the fact whether the reported volumes of 'loud' and 'very loud' were capable of causing hearing damage. However, Muchnik et al. [10] and Sulaiman et al. [11] found a positive correlation between the self-reported listening volume and the actual preferred listening levels. Hence, it can be assumed that 'loud' and 'very loud' music listening levels can pose a high risk for hearing damage.

Conclusion:

We studied music listening behavior in adolescents across three groups (HS, PU, and UG level) as a function of age and education level; and noted their knowledge about music-induced hearing loss. Our results show that a greater proportion of the younger generation listen to music daily using mobile phones with earphones as an accessory at loud volume. Thus, the younger adolescent group (HS) is at a greater risk for potential damage to hearing from music than older adolescents (UG). Further, the younger group (HS) is also least aware of the damage caused by music listening at a very loud level. Hence, we underscore the importance of creating awareness about hearing conservation and loud music-induced hearing loss in the adolescent population as early as 13 years of age. Furthermore, safety standards and exposure guidelines should be developed for safe music listening.

Source of fund: Nil

Conflict of interest: Nil

Authors's contribution:

Idea, conceptualization: US, MK

Study design: US, MK

Data gathering: GNS, SL

Writing and submitting manuscript: US, GNS, SL, MK

Editing and approval of final draft: US, GNS, SL, MK

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