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Educational system to estimate the sound levels of earphones in teenagers

Sistema educativo para estimar os níveis sonoros de fones de ouvido em adolescentes

Sistema educativo para estimar los niveles sonoros de audífonos en adolescentes

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Abstract

The use of personal stereo equipment by teenagers is a reality observed in our day-to-day lives, and the intensity levels used are alarming. **Objective:** To present an educational system to track the sound levels of earphones of teenagers who are users of portable sound equipment (PSE). **Method:** 49 teenagers of a public school in the State of São Paulo composed the sample. Estimations of the Sound Pressure Level (SPL), filter A, were made using an educational system to estimate the sound pressure level. This system was developed by the Dangerous Decibels.org® program and named Jolene (United States) and Gisele D'Barulho (Brazil). The obtained answers were analyzed in a descriptive way in percentage, average, median and mode values. **Results:** The value sets to sound pressure level, obtained through the Gisele D'Barulho was 104 dB (A), and the highest levels were found in the male group. The system proved effective in motivating young people to participate in the research. **Conclusions:** this system to track the sound intensity level met the educational objectives of showing the participants which sound volume they were using. This technique allowed to show that they are using their portable sound equipment with intensity above of what is recommended, increasing the chances of having hearing problems in the near future.

Keywords: Adolescent; Education; Ear; Hearing; Noise.

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Authors' contributions:
SBL and SVS– data collection with application of the educational system
TMMS and ABMF - correction of the written material and contribution to the discussion

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Resumo

O uso de equipamento estéreo pessoal por jovens é uma realidade observada no dia a dia e os níveis de intensidade utilizados são preocupantes. **Objetivo:** Apresentar um sistema educativo para rastrear os níveis sonoros de fones de ouvido de adolescentes usuários de equipamentos portáteis de som (EPS). **Método:** A amostra foi composta por 49 adolescentes de uma de uma escola pública do Estado de São Paulo. Foram feitas as estimativas do Nível de Pressão Sonora (NPS), filtro A, com a utilização de um sistema educativo para estimar o nível de pressão sonora. Este sistema foi desenvolvido pelo programa Dangerous Decibels.org® e recebeu o nome de Jolene (Estados Unidos) e Gisele D'Barulho (Brasil). As respostas obtidas foram analisadas de forma descritiva em valores de % e de média, mediana e moda. **Resultados:** O valor de moda para nível de Pressão Sonora, obtidos através do Sistema Gisele D'Barulho, foi de 104 dB (A), sendo que foram encontrados os níveis mais elevados no grupo do sexo masculino. O Sistema mostrou-se eficaz na motivação dos jovens a participarem da pesquisa. **Conclusões:** esse sistema de rastreio do nível de intensidade sonora atendeu os objetivos educativos de mostrar para os participantes qual o volume de som que estavam usando. Essa técnica permitiu mostrar que estão utilizando os seus equipamentos portáteis de som em intensidade acima do recomendado, aumentando as chances de problemas auditivos em futuro próximo.

Palavras-chave: Adolescente; Educação; Orelha; Audição; Ruído.

Resumen

El uso de auriculares por jóvenes es una realidad observada en el día a día y los niveles de intensidad utilizados son preocupantes. **Objetivo:** Presentar un sistema educativo para rastrear los niveles sonoros de audífonos de adolescentes que usan equipamientos portátiles de sonido (EPS) **Método:** La muestra fue compuesta por 49 adolescentes de una escuela pública del Estado de São Paulo. Fueron hechas estimativas del Nivel de Presión Sonora (NPS), filtro A, con la utilización de un sistema educativo para estimar el nivel de presión sonora. Este sistema fue desarrollado por el programa Dangerous Decibeles. org® y recibió el nombre Jolene (Estados Unidos) y Gisele D'Barulho (Brasil). Las respuestas obtenidas fueron analizadas de forma descriptiva en valores de % de promedio, mediana y moda. **Resultados:** El valor se establece en el nivel de presión sonora obtenido mediante el sistema de Gisele D'Barulho 104 dB (A) y los niveles más altos se encontraron en el grupo masculino. El sistema probó eficaz en motivar los jóvenes a participar en la investigación. **Conclusiones:** Este sistema de rastreo del nivel de intensidad sonora atendió a los objetivos educativos de mostrar a los participantes cual era el volumen del sonido que estaban utilizando. Esta técnica permitió mostrar que están utilizando sus equipamientos portátiles de sonido en intensidad arriba de lo recomendado, aumentando las chances de tener problemas auditivos en un futuro próximo.

Palabras claves: Adolescente; Educación; Oído; Audición ; Ruido.

Introduction

Exposure to intense sound, whether it is noise, music, occupational or leisure, can result in noise-induced hearing loss (NIHL). This loss arises slowly and gradually, and as it is caused by an invisible energy, people do not realize that they are exposed to this risk and that they are being effectively affected by it, so they usually do not give much importance to its prevention. As hearing loss is often asymptomatic, it is only perceived when it progresses enough to affect speech and communication[1.]

The use of headphones to listen to music, play video games or even at bedtime is a frequent habit in young people.[2-4] The use of headphones with personal stereo systems (PSS) has increased significantly in recent years as part of the daily life of people in the most varied activities[1,5-8]. Often, these headphones are used in such a high volume that people around them are able to clearly hear the sound being played directly in the ear of the individual with the device.

Since technological advances are providing increasingly powerful personal stereo systems with a longer battery life, which allows the user to have uninterrupted hours of exposure to sound, this situation has become a cause of concern for society in general[9-10]. The preference for the use of insertion earphones further aggravates the situation, since the earphone is positioned in the external acoustic meatus, which places the sound closer to the tympanic membrane of the individual[8-9, 11-13].

Studies show that young people are using their personal stereo systems at levels above those recommended, often at high volume or at the maximum output of the equipment and for more than two hours a day[2-3, 7, 9, 11, 13-15]. Although they understand that they are exposed to high intensity sounds[16], many young people are not aware that this exposure causes hearing loss[5,7].

The Dangerous Decibels® program that was developed at the University of Oregon, United States, has developed a very efficient instrument to demonstrate how people are not aware about the sound, the loudness, and the auditory risk to which they are exposed. Among the different strategies used by the program, this organization uses a fashion mannequin and a sound level meter wired to a silicon ear. She was named as Jolene[1]* The microphone for sound pressure level meter is placed at the end of the external acoustic meatus of the silicone ear, and this is placed on the mannequin's head simulating a real ear. By placing a headphone on the mannequin's external acoustic meatus it is possible to measure the sound pressure level that the person would be hearing on his/her personal stereo system (PSS) or portable sound equipment.

The World Health Organization (WHO, 2017) estimates that 1.1 billion young people are at risk of hearing loss due to unsafe ear listening practices. The current trend to regularly listen to high-volume and long-lasting music poses a serious threat to hearing. "As a result of the concern of future adults with hearing and communication disorders, the WHO intends to develop determinations that limit exposure to loud sounds and strategies to raise awareness on the safe use of recreational sounds[17]. The Dangerous Decibels® program, which is based on the occupational health studies of the National Institute for Occupational Safety and Health (NIOSH), has developed an interactive educational activity that allows children and young people to know the risks that an 8-hour daily exposure to a sound of 85 dBA would bring for their hearing[18].

The continuous exposure to high-intensity sounds is a public health issue that must be further investigated and disseminated, more and more, starting from the learning environment, that is, the school, in order to reach children and young people. The purpose of these hearing health programs for children and young people is to change the attitude and behavior of this group with respect to loud music exposure.

One of the strategies that can be used is to assess the intensity with which these groups use their headphones and to compare them with the perception related to this sound. It can be noticed that there are few educational resources that allow this population to experience and "measure" the sound level of their personal stereo system (PSS). In an attempt to describe what they hear, they do not know how to estimate the size of the energy to which they are exposed. This study establishes a hypothesis that there is no relation between the estimated value in the dB sound pressure level in the headphones used by these young people and

1* http://www.dangerousdecibels.org/education/jolene/cookbook/

their understanding of this sound; therefore, young people are not aware of the auditory risk to which they are exposed.

The educational system developed by the Dangerous Decibels® program may allow young people to have an estimate, close to the real one, of how much sound energy they are exposed to when listening to music with headphones in their PSS. Thus, the objective of this work is to present an educational system to track the sound levels of earphones of teenagers who are users of personal stereo sounds (PPS).

Method

This is an exploratory, descriptive study that was approved by the Ethics Committee under the number 06539712.7.0000.5482, which was carried out with adolescents from a teaching institution in São Paulo.

The sample consisted of 49 adolescents, students, regularly enrolled in the 5th and 8th grade of the elementary school of São Paulo. The age range varied between 10 and 17 years of age. The non-consent of their parents or the refusal of the young person to participate in the research were considered exclusion criteria.

The sound level estimate of the headphones coupled to the PSS of the students was performed through a system composed of a mannequin with a silicone ear attached to the head - 'Gisele D'Barulho' (INSERT FIGURE 1).

A Realistic model microphone, from Radio Schak brand, is coupled to a sound pressure level meter and is inserted into this ear.

This system is a replica of the one developed at the University of Oregon - USA, Jolene DOSHU, which is part of the Dangerous Decibels® program.

The sound pressure level meter was set to perform measurements in dB SPL, filter A and slow mode values. Students were instructed to connect their personal stereo systems (PSS) at the same volume level that they usually use and to connect the headphones to the 'ear' of the 'Gisele D'Barulho' system.

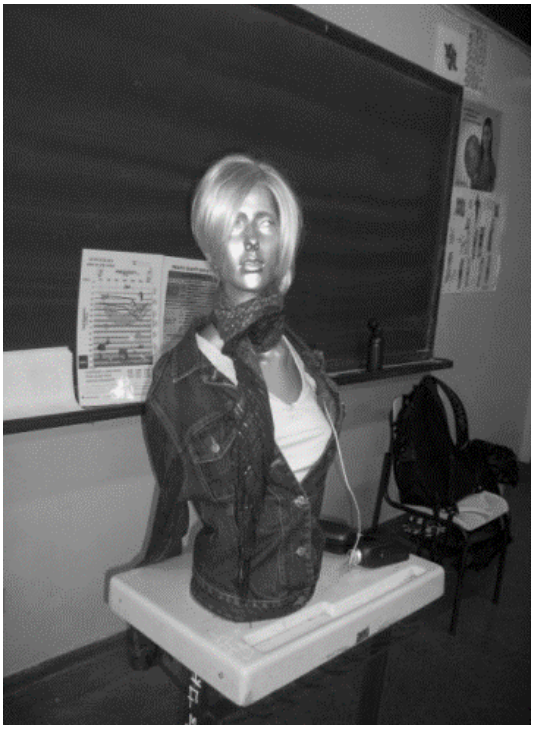


Figure 1. Gisele D´Barulho system.

Information was recorded concerning the personal stereo system model used by the student; dB(A) sound level value as displayed on the sound pressure level meter display; age and gender of the student. The responses were tabulated in Excel and then analyzed and described in mean, median, mode, standard deviation, minimum and maximum values.

Results

Table 1. Descriptive analysis in mean, mode, standard deviation, median, minimum and maximum values related to the age.

	AGE (YEARS)
MEAN	13.2
MEDIAN	14
MODE	14
MINIMUM	10
MAXIMUM	17
SD	2.0

Legend: SD=standard deviation.

Table 2. Distribution of the sample with respect to the gender in percentages (n=49)

GENDER	No. of subjects	%
FEMALE	23	47%
MALE	26	53%
TOTAL	49	100%

Legend: n=number of subjects; %=percentage.

Table 3. Descriptive analysis of mean, mode, standard deviation, median, minimum, and maximum values of dB(A) SPL measurements obtained with the Gisele D'Barulho system

	Mean	SD	Median	Mode	Minimum	Maximum
dB(A)	97.7	10.0	97.0	104.0	73.0	120.0

Legend: SD=standard deviation.

Table 4. Sample distribution with respect to age, %.

AGE	No. of subjects	%
10	8	16%
11	6	13%
12	1	2%
13	6	13%
14	15	30%
15	7	14%
16	5	10%
17	1	2%
TOTAL	49	100%

Legend: n=number of subjects; %=percentage.

Table 5. Analysis of gender and sound level in dB(A) values found in the sample (n=49)

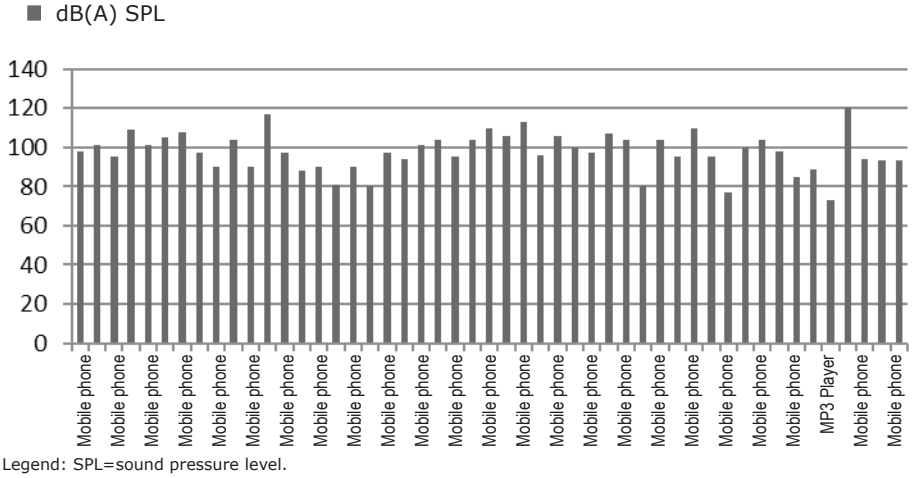
SPL dB(A)		70-80	81-90	91-100	101-110	111-120	Total
Gender	M	1 (4%)	6 (23%)	**9 (35%)**	7 (27%)	3 (11%)	26 (53%)
	F	3 (13%)	2 (8%)	8 (35%)	**10 (44%)**	0 (0%)	23 (47%)
Total							49 (100%)

Legend: SPL=sound pressure level; M=male; F=female.

Table 6. Analysis of age and sound level in dB(A) values found in the sample (n=49)

Age	dB(A) SPL				
	70-80	81-90	91-100	101-110	111-120dB(A)
	N%	N%	N%	N%	N%
10	**3 (37.5%)**	1 (12.5%)	**3 (37.5%)**	1 (12.5%)	0 (0%)
11	0 (0%)	1 (17%)	**2 (33%)**	**2 (33%)**	1 (17%)
12	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)
13	0 (0%)	**3 (50%)**	**2 (33%)**	1 (17%)	0 (0%)
14	0 (0%)	3 (20%)	**5 (33%)**	**7 (47%)**	0 (0%)
15	1 (14%)	0 (0%)	2 (29%)	**4 (57%)**	0 (0%)
16	0 (0%)	0 (0%)	1 (20%)	**2 (40%)**	**2 (40%)**
17	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)

Legend: SPL=sound pressure level; N%=number of subjects and percentage.



Legend: SPL=sound pressure level.

Figure 2. dB(A) SPL measure obtained with the Gisele D'Barulho system for personal stereo systems (PSSs) used by the sample.

Discussion

As shown in Table 2, the age of students ranged from 10 to 17 years and most of them were 14 years old. Regarding gender, the sample consisted of a greater number of male adolescents (53%), which is in line with the study published by Widen et al.[2]. The sound pressure levels found in this study reached a maximum of 120 dB(A), and the mode value (higher frequency) was 104 dB(A), as shown in Table 1. The results are even greater than those reported in the literature[2, 11,14,15].

As shown in table 6, this study shows that 16-year-old students are the group exposed to more intense levels (110-120 dB (A)), while 10-year-old students are those who use their devices in a less intense volume (70-80 dB(A)). During the research, it was possible to notice that some students aged between 10 and 11 years did not participate in the measurements, since their parents do not let them use headphones. This shows that parents are concerned with the use of headphones, not only for the hearing damages caused by it, but mainly because it causes dispersion during classes and for 'distancing' these young people from family life. Research has shown that male students use their PSS at higher intensities than female participants (as shown in Table 5), which is in line with the results of another study that found more harmful habits in the female population[13].

The results found in the dB(A) SPL presented poor values, as they show that most of the adolescents are exposed to levels well above the levels that are recommended to avoid damages to hearing. The most common levels found ranged from 101-110 dB(A). The daily exposure at these sound levels should be of 1 hour for 100 dB(A) and 15 minutes for 110 dB(A) in work or leisure environments[19-20].

The literature shows that noise-exposed young people show changes in tests that evaluate the auditory threshold in high frequencies and in the otoacoustic emission[5-6, 9, 21], in addition to presenting, in great majority, tinnitus after exposure to sound, thus demonstrating an early cochlear change[2, 4, 10-11, 13-14, 22-25]. As for future perspectives, it is possible to have a scenario with adults with hearing impairments and having to use hearing aids at an earlier age. Several authors agree that it is extremely important to implement programs to aware young people on the auditory risk to which they are exposed to[1, 6-7, 11, 13-14, 21, 26-28]. In addition to the involvement of the government in regulating the sound level limits in devices[29] and to the publication of greater scientific evidence on the auditory risk caused by leisure noise[30], it is important that this population becomes aware of the need to change attitudes and behavior in order to avoid potential consequences in the future. The young people who participated were not concerned with hearing and it could be observed in some comments, such as '*I like loud music*'; and '*I' won't change my habits*'. Parents also have a great influence on the education of their children and, therefore, should be educated about hearing impairments and hearing care, so that they could assist them in their attitudes and choices.

Despite knowing that these measurements are not accurate, from an acoustic point of view, this system allowed an interaction with adolescents, as it drew the attention to the subject, and also generated a discussion and questions about hearing. The Gisele D'Barulho system can be used in events, as it is easy to handle and move, in addition to reaching a significant number of young people.

Conclusion

This system proved to be a powerful strategy to encourage young people to take care of their hearing habits, since they were able to see the intensity level directed to their ears in a didactic, illustrative and entertaining way.

More than 40% of the young people use PPSs with earphones in high intensity for more than 30 minutes every day, with sound pressure levels ranging between 73-120 dB(A), and a mode value of 104 dB(A). This shows the great auditory risk to which these young people are exposed and also reinforces the need to develop strategies to educate this population on the possibility of losing their hearing.

References

1. Hong SM, Park II-S, Kim YB, Hong SJ, Lee B. Analysis of the Prevalence of and Factors Associated with Hearing Loss in Korean Adolescents. Published online 2016. Disponível em doi: 10.1371/journal.pone.0159981. Acesso em: 06 de Agosto de 2017.

2. Widen SE, Båsjö S, Möller C, Kähäri K. Headphone listening habits and hearing thresholds in Swedish adolescents. Noise Health. 2017; 19: 25-132.

3. Dehnert K, Raab U, Perez-Alvarez C, Steffens T, Bolte G, Fromme H, et al. Total leisure noise exposure and its association with hearing loss among adolescents. Int J Audiol. 2015; Early Online: 1–9 International Journal of Audiology. Disponível em: http://dx.doi.org/10.3109/14992027.2015.1030510. Acesso em: 05 de Agosto de 2017.

4. Keppler H, Dhooge I, Vinck B. Hearing in young adults. Part II: The effects of recreational noise exposure. Noise Health. 2015; 17 (78): 245.

5. Biassoni CE, Serra MR, Hinalaf M, Abraham M, Pavlik M, Villalobo JP, et al. Auditiva e exposição a música alta em um grupo de adolescentes com idades de 14-15 e reaplicado no 17-18. Rev. Ruído Saúde 2014; 16: 331-41.

6. Barcelos DD, Dazzi NS. Efeitos do MP3 player na audição. Rev. CEFAC. 2014 Mai-Jun; 16(3): 779-91.

7. França AG, Lacerda ABM. Promoção da saúde auditiva: estratégias educativas desenvolvidas por estudantes do ensino médio. Distúrb. Comun. 2014; 26(1): 365-72.

8. Santos I, Colella-Santos MF, Couto CM. Sound pressure level generated by individual portable sound equipment. Braz J Otorhinolaryngol. 2014; 80:41-7.

9. Melo T. Perfil audiológico de jovens usuários de dispositivos de escuta pessoal. Distúrb. Comun. 2014; 26(2): 337-47.

10. Sulaiman AH, Husain R, Seluakumaran K. Hearing Risk among Young Personal Listening Device Users: Effects at High-Frequency and Extended High-Frequency Audiogram Thresholds. J Int Adv Otol. 2015; 11(2): 104-9.

11. Santana PDF, Mascarenhas WN, Borges LL, Camarano MRH. Hábitos de jovens usuários de dispositivos eletrônicos individuais e sintomas advindos da exposição à música em forte intensidade. Rev. Estud GO. 2015; 42 (3): 315-26.

12. Marques APC, Filho ALM, Monteiro GTR. Prevalência de perda auditiva em adolescentes e adultos jovens decorrentes de exposição a ruído social: meta-análise. Rev. CEFAC. 2015; 17(6): 2056-64.

13. Silvestre RA, Ribas Â, Hammerschmidt R, de Lacerda AB. High-frequency profile in adolescents and its relationship with the use of personal stereo devices. Rev. J Pediatr. 2016; 92: 206-11.

14. Do Carmo MP, Momensohn-Santos TM. Queixas e hábitos auditivos de usuários de equipamento portátil de som. Distúrb. Comun. 2016; 28(4): 694-700.

15. Fligor BJ, Levey S, Levey T. Cultural and Demographic Factors Influencing Noise Exposure Estimates from Use of Portable Listening Devices in an Urban Environment. Journal of Speech Language and Hearing Research. 2014; 57(4): 1535-47.

16. Beach EF, Williams W, Gilliver M. The objective-subjective assessment of noise: Young adults can estimate loudness of events and lifestyle noise. Int J Audiol. 2012; 51: 444-9.

17. WHO-ITU Consultation on Make Listening Safe. Disponível em: <http://www.who.int/pbd/deafness/mls_consultation/en/>. Acesso em: 06 de Agosto de 2017.

18. Decibel exposure time guidelines. Disponível em: <http://dangerousdecibels.org/education/information-center/decibel-exposure-time-guidelines/>. Acesso em: 06 de Agosto de 2017.

19. NIOSH. Disponível em: < https://www.cdc.gov/niosh/topics/noise/defaul>. Acesso em: 25 de Fevereiro de 2018.

20. NR15 do Ministério do Trabalho. Disponível em: <http://trabalho.gov.br/images/Documentos/SST/NR/NR15/NR15-ANEXO1.pdf>. Acesso em: 25 de Fevereiro de 2018.

21. Lee GJC, Lim MY, Kuan AYM, Teo JHW, Tan HG, Low WK. Relationship between leisure noise exposure and otoacoustic emissions in a young Asian population. Int J Audiol. 2014; 53: 462-8.

22. Serra MR, Biassoni EC, Hinalaf M, Abraham M, Pavlik M, Villalobo JP, et al. Hearing and loud music exposure in 14-15 years old adolescents. Noise Health. 2014; 16: 320-30.

23. Correa BM, Silveira AF, Bonfante D, Costa MJ, Biaggio EPV. Hábitos e queixas auditivas de adolescentes usuários de estéreos pessoais. Rev. CEFAC. 2016; 18(2): 348-54.

24. Gilles A, Van Hal G, De Ridder D, Wouters K, Van de Heyning P. Epidemiology of Noise-Induced Tinnitus and the Attitudes and Beliefs towards Noise and Hearing Protection in Adolescents. Disponível em: <https://doi.org/10.1371/journal.pone.0070297> Acesso em: 05 de Agosto de 2017.

25. Moore DR, Zobay O, Mackinnon RC, Whitmer WM, Akeroyd MA. Lifetime leisure music exposure associated with increased frequency of tinnitus. Hear Res. 2017; 347: 18–27. Disponível em: doi: 10.1016/j.heares.2016.10.030. Acesso em 25 de Fevereiro de 2018.

26. Lacerda ABM, Soares VMN, Goncalves CGO, Lopes FC, Testoni R. Oficinas educativas como estratégia de promoção da saúde auditiva do adolescente: estudo exploratório. Audiology: Communication Research. 2013; 18(2): 85-92. :

27. Oliveira MFF, Andrade KCL, Macambira YKS, Santos ETU, Carnaúba ATL, Menezes PL. Eficácia da versão brasileira do programa Educacional Decibéis Perigosos. Distúrb. comun. 2015; 27(2): 406-7.

28. Blasca WQ, Picolini MM, Silva ASC, Campos K, Pinto GFR, Brasolotto AG, et al. Projeto Jovem Doutor Bauru: capacitação de estudantes do ensino médio em saúde auditiva. Rev. CEFAC [online]. 2013, 15(6): 1407-1417. Disponível em: <http://dx.doi.org/10.1590/S1516-18462013005000035>. Acesso em: 06 de Agosto de 2017.

29. Keppler H, Ingeborg D, Sofie D, Bart V. The effects of a hearing education program on recreational noise exposure, attitudes and beliefs toward noise, hearing loss, and hearing protector devices in young adults. Noise Health. 2015; 17(78): 253–62.

30. Carter L, Williams W, Black D, Bundy A. The Leisure-Noise Dilemma: Hearing Loss or Hearsay? What Does the Literature Tell Us? Ear Hear. 2014; 35(5): 491-505.