

## Student's music exposure: Full-day personal dose measurements

By: Nilesh Jeevandas Washnik, [Susan L. Phillips](#), Sandra Teglas

Washnik, N. J., Phillips, S. L., & Teglas, S. (2016). Student's music exposure: Full-day personal dose measurements. *Noise & Health*, 18(81), 98-103. doi:10.4103/1463-1741.178510

**\*\*\*© Medknow Publications. Reprinted with permission. No further reproduction is authorized without written permission from Medknow Publications. This version of the document is not the version of record. Figures and/or pictures may be missing from this format of the document. \*\*\***

Made available courtesy of Medknow Publications: <http://dx.doi.org/10.4103/1463-1741.178510>.



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](#).

### **Abstract:**

Previous studies have shown that collegiate level music students are exposed to potentially hazardous sound levels. Compared to professional musicians, collegiate level music students typically do not perform as frequently, but they are exposed to intense sounds during practice and rehearsal sessions. The purpose of the study was to determine the full-day exposure dose including individual practice and ensemble rehearsals for collegiate student musicians. Sixty-seven college students of classical music were recruited representing 17 primary instruments. Of these students, 57 completed 2 days of noise dose measurements using Cirrus doseBadge programed according to the National Institute for Occupational Safety and Health criterion. Sound exposure was measured for 2 days from morning to evening, ranging from 7 to 9 h. Twenty-eight out of 57 (49%) student musicians exceeded a 100% daily noise dose on at least 1 day of the two measurement days. Eleven student musicians (19%) exceeded 100% daily noise dose on both days. Fourteen students exceeded 100% dose during large ensemble rehearsals and eight students exceeded 100% dose during individual practice sessions. Approximately, half of the student musicians exceeded 100% noise dose on a typical college schedule. This finding indicates that a large proportion of collegiate student musicians are at risk of developing noise-induced hearing loss due to hazardous sound levels. Considering the current finding, there is a need to conduct hearing conservation programs in all music schools, and to educate student musicians about the use and importance of hearing protection devices for their hearing.

**Keywords:** ensemble | noise dose | noise dosimetry | rehearsals

### **Article:**

# Student's music exposure: Full-day personal dose measurements

Nilesh Jeevandas Washnik, Susan L. Phillips, Sandra Teglas<sup>1</sup>

Department of Communication Sciences and Disorders, University of North Carolina, <sup>1</sup>Music Research Institute, School of Music, Theatre and Dance, University of North Carolina, Greensboro, North Carolina, USA

## Abstract

Previous studies have shown that collegiate level music students are exposed to potentially hazardous sound levels. Compared to professional musicians, collegiate level music students typically do not perform as frequently, but they are exposed to intense sounds during practice and rehearsal sessions. The purpose of the study was to determine the full-day exposure dose including individual practice and ensemble rehearsals for collegiate student musicians. Sixty-seven college students of classical music were recruited representing 17 primary instruments. Of these students, 57 completed 2 days of noise dose measurements using Cirrus doseBadge programed according to the National Institute for Occupational Safety and Health criterion. Sound exposure was measured for 2 days from morning to evening, ranging from 7 to 9 h. Twenty-eight out of 57 (49%) student musicians exceeded a 100% daily noise dose on at least 1 day of the two measurement days. Eleven student musicians (19%) exceeded 100% daily noise dose on both days. Fourteen students exceeded 100% dose during large ensemble rehearsals and eight students exceeded 100% dose during individual practice sessions. Approximately, half of the student musicians exceeded 100% noise dose on a typical college schedule. This finding indicates that a large proportion of collegiate student musicians are at risk of developing noise-induced hearing loss due to hazardous sound levels. Considering the current finding, there is a need to conduct hearing conservation programs in all music schools, and to educate student musicians about the use and importance of hearing protection devices for their hearing.

**Keywords:** Ensemble, noise dose, noise dosimetry, rehearsals

## Introduction

Since 1969, research has shown that excessive music exposure is associated with hearing loss.<sup>[1-6]</sup> A specific population at risk is professional musicians, and some evidence indicates that professional musicians incur a significant hearing loss.<sup>[7-9]</sup> However, other studies have not found significant hearing loss in musicians.<sup>[10,11]</sup> Given these conflicting results, an initial question to ask is whether musicians experience overexposure.

Professional musicians are frequently exposed to hazardous sound levels while they perform.<sup>[12-14]</sup> Collegiate level music students are also exposed to potentially hazardous sound levels throughout the day. Although collegiate level

music students do not perform as frequently as professional musicians, typically, they maintain a rigorous practice schedule, which increases their chances of developing hearing loss. Gopal *et al.*<sup>[15]</sup> compared sound exposure levels during 50 min jazz ensemble rehearsal and 50 min regular classroom activity (nonmusic) and found that the equivalent continuous noise level (Leq) during jazz ensemble ranged from 95 dBA to 105.8 dBA, whereas in regular classroom activity, the Leq ranged from 46.4 dBA to 67.4 dBA. Gopal *et al.* also found significant temporary threshold shifts (TTSs) bilaterally at 4 kHz and significant reduction in transient-evoked otoacoustic emission (TEOAE) amplitudes bilaterally in student musicians after 50 min of a jazz

Access this article online	
Quick Response Code:	Website: <a href="http://www.noiseandhealth.org">www.noiseandhealth.org</a>
	DOI: 10.4103/1463-1741.178510

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

**For reprints contact:** [reprints@medknow.com](mailto:reprints@medknow.com)

**How to cite this article:** Washnik NJ, Phillips SL, Teglas S. Student's music exposure: Full-day personal dose measurements. *Noise Health* 2016;18:98-103.

ensemble rehearsal. Nonmusic major students did not show any significant difference in threshold and TEOAE amplitude after 50 min of regular classroom activity. In another study, Phillips *et al.*<sup>[16]</sup> found that 45% of student musicians had a 4-6 kHz notch in at least one ear. One possible contributing factor for hearing loss among student musicians is their overall exposure to sound during a typical day. There is no previous determination that the noise dose in student musicians exceeds the hazardous limits during their full-day college schedule.

There are three important factors that need to be considered in analyzing sound exposure among student musicians: Personal dosimetry measurements versus fixed point measurements, the use of National Institute for Occupational Safety and Health (NIOSH) criterion versus Occupational Safety and Health Administration (OSHA) criterion, and day-long measurements versus measurements of practice, rehearsals, or performance sessions.

For personal dosimetry and fixed-point measurements, a noise dosimeter is used. This instrument measures the cumulative noise exposure over time. This measurement can be carried out in one of the two ways:

1. It can be worn on the body of an individual to measure the individual's sound exposure or
2. It can be mounted on a wall to measure the sound level of the room/area.

Previous studies on sound exposure in musicians have used two measurement approaches to obtain doses: Individual measurements<sup>[8,15,17]</sup> or fixed-point measurements.<sup>[13,18]</sup> The sound exposure of a student musician may vary according to the distance from the sound source, as observed in ensembles sessions where the distance between a musician and other sound sources varies from instrument to instrument. Comparatively, individual measurements provide more accurate information about the sound exposure of a specific student musician than do fixed-point measurements.

NIOSH and the OSHA criteria are the two major criteria available for measuring occupational sound level in the United States, and measurement outcomes vary depending on the criterion used. The OSHA mandates one of the criteria in its regulations, specifying that the measurement instrument, i.e., noise dosimeter is required to be set with an 80 dB threshold, 90 dB criterion level, and 5 dB exchange rate. The National Institute of Occupational Safety and Health specifies that an 80 dB threshold, 85 dB criterion level, and 3 dB exchange rate can be used when measuring sound exposure. The NIOSH criterion is more conservative than the OSHA criterion due to the lower threshold value and the 3 dB exchange rate. Miller *et al.*<sup>[18]</sup> compared noise exposure levels for both measurement criteria in an ensemble and found that the daily noise dose value using the OSHA criteria ranged from approximately 200-700% noise dose, whereas

when using the NIOSH criteria, the noise dose values varied from 1600% to a 17,000% noise dose.

Student musicians are exposed to variable levels of sounds during a typical day, which includes classroom activities, listening to music pieces through speakers, individual practice sessions, small and large ensembles rehearsals, lectures, and breaks throughout the day. Variability in sound exposure level to musicians could also be due to the differences in repertoire, primary music instruments, type of music, physical environment (i.e., concert halls, orchestra pits, or other venues), inter-musician and intra-musician variability.<sup>[19]</sup> The majority of studies about sound exposure in musicians have measured either a single session or a few sessions of solitary practice, group rehearsals, or performance sessions.<sup>[8,17,20-22]</sup> Previous research in noise exposure has been conducted on industrial workers throughout a standard 8-h shift. To our knowledge, this is the first study which measured noise exposure for student musicians throughout a full-day of exposure using personal dosimeters programed with NIOSH criteria. The purpose of this study is to determine the daily exposure dose as well as the noise dose for individual practice and ensemble rehearsals for collegiate student musicians. The findings of the study may help to predict which students are at risk for excessive sound exposure.

## Methods

### Participants

Sixty-seven collegiate students of classical music (aged 18-25) from the School of Music volunteered to participate in the sound exposure measurement study. Ten students were excluded from the original sample of 67 students as they participated only for 1 day. Fifty-seven students were categorized by their primary instruments (bass trombone-1, bassoon-2, cello-2, clarinet-4, flute-2, horn-2, oboe-2, percussion-7, piano-4, saxophone-4, trombone-3, trumpet-5, tuba-2, viola-3, violin-1, and voice-13). This study was approved by the UNCG Institutional Review Board.

### Procedure

Sound exposure measurements were completed on 2 days of normal music student activities. One day represented the Monday-Wednesday-Friday class schedule and the other day represented the Tuesday-Thursday class schedule. Sound exposure was measured for 2 days from morning to evening; typically for 7-9 h. Measurements were taken using the Cirrus doseBadge noise dosimeter (Hunmanby, North Yorkshire, United Kingdom) mounted within 10-12 cm of one ear of each musician. The doseBadge noise dosimeters were placed on students at the start of the day to measure the sound exposure and removed at the end of the day, when they were placed into the doseBadge reader. Measurements were downloaded to a Windows-based computer to compute 1-min averages, daily averages (Leq), and daily sound dose percentages according to NIOSH criterion. The NIOSH

criterion was preferred over OSHA because it is based on the findings of studies related to noise exposure and hearing loss, and the NIOSH values are more conservative than OSHA values. Calculations were exported to Microsoft Excel for study and comparative calculations of dose percentages for each day and each activity.

During the measurement day, students were asked to complete a log sheet to report their schedule over the course of the day, noting types of activities, and the times they began and ended each activity. Based on this report, the noise dose measurements were classified into large ensemble rehearsals and individual practice sessions.

## Results

The analysis demonstrated that 28 out of 57 (49%) student musicians exceeded 100% daily noise dose on at least 1 day of the two measurement days [Table 1]. Eleven student musicians (19%) exceeded 100% daily noise dose on both days: One flute, two horn, four saxophone, one trombone, one trumpet, and two voice. Two outliers (one each from percussion and voice) were eliminated using a  $\pm 2$  standard deviations (SD) criterion. The number of students exceeding 100% noise dose in large ensemble rehearsals was greater than the number of students in individual practice sessions. Individual exposure measurements were graphed based on their primary instrument. The contribution to the total noise dose from individual practice and large ensembles was also analyzed and is shown in Figures 1-3.

In Figure 1, it can be seen that nearly half (49%) of the student musicians exceeded a 100% dose on at least 1 day,

**Table 1: Number of students exceeding 100% noise dose (at least 1 day of 2 measurement days) during individual practice, large ensembles, and full-day**

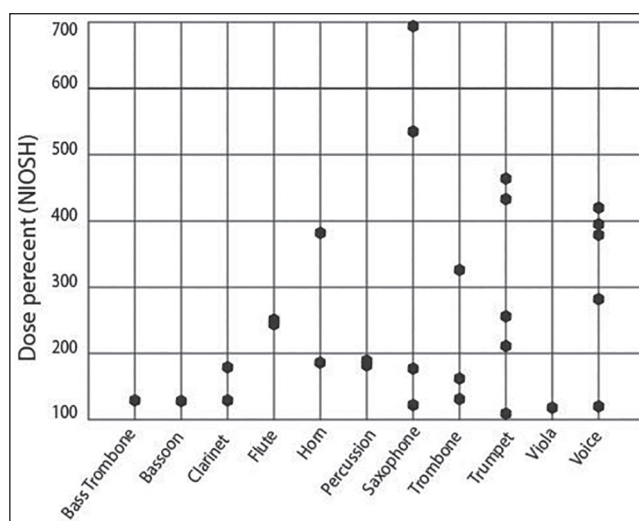
Instruments	Number of students exceeding 100% noise dose on any 1 day of measurement		
	Individual practice	Large ensemble	Full-day
Bass trombone ( $n=1$ )	0	0	1
Bassoon ( $n=2$ )	0	0	1
Cello ( $n=2$ )	0	0	0
Clarinet ( $n=4$ )	0	1	2
Flute ( $n=2$ )	2	2	2
Horn ( $n=2$ )	0	2	2
Oboe ( $n=2$ )	0	0	0
Percussion ( $n=7$ )	0	0	2
Piano ( $n=4$ )	0	0	0
Saxophone ( $n=4$ )	2	3	4
Trombone ( $n=3$ )	1	2	3
Trumpet ( $n=5$ )	1	4	5
Tuba ( $n=2$ )	0	0	0
Viola ( $n=3$ )	0	0	1
Violin ( $n=1$ )	0	0	0
Voice ( $n=13$ )	3	0	7

representing 11 out of 16 instruments. Almost one-fifth (19%) of the student musicians exceeded 100% daily noise dose on both days. All of the students of saxophone ( $n = 4$ ) and horn ( $n = 2$ ) exceeded 100% noise dose on both days. One student of the flute ( $n = 2$ ), one student of the trombone ( $n = 3$ ), two students of the trumpet ( $n = 5$ ), and two students of voice ( $n = 13$ ) exceeded 100% noise dose on both days.

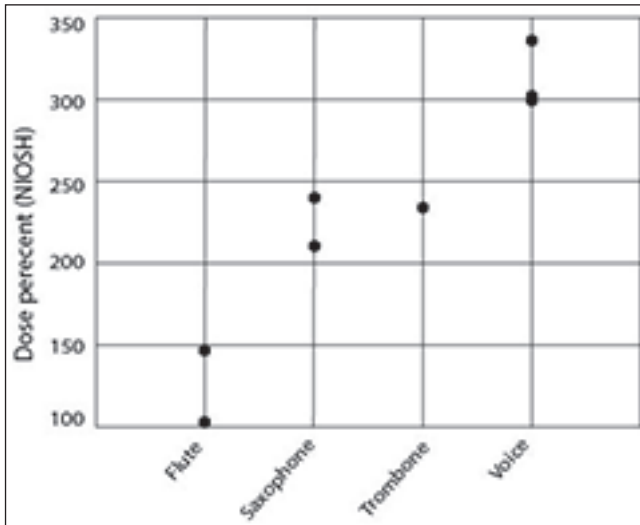
Figure 2 shows the noise dose during individual practice of eight students that exceeded 100% noise dose on 1 of the 2 measurement days, grouped by primary instrument. Three outliers were eliminated from the analysis using  $\pm 2$  SD criterion. Students with other primary instruments did not exceed 100% noise dose during individual practice sessions. However, this exposure may still be potentially hazardous, particularly when combined with other exposures such as practicing in small and large ensembles, listening to music through speakers, and music pieces played by other students during the day. One student of voice exceeded 100% noise dose on both days of measurement.

Figure 3 shows the noise dose of 14 student musicians exceeding 100% on one of the days of measurement while playing their primary instrument in large ensembles (one outlier exceeding  $\pm 2$  SD was removed from the data). In large ensembles, the noise dose exceeds 100% for student musicians: One of the clarinet ( $n = 4$ ), two of the flute ( $n = 2$ ), two of the horn ( $n = 2$ ), three of the saxophone ( $n = 4$ ), two of the trombone ( $n = 3$ ), and four of the trumpet ( $n = 5$ ). One student of horn and one student of trumpet exceeded noise dose on both days of measurement. For players of the remaining instruments, the noise doses in large ensembles were below 100%.

The sound exposure during individual practice sessions and in small and large ensembles rehearsals contributed to each



**Figure 1: Daily noise dose by instrument for student musicians who exceeded 100% dose on at least 1 day ( $n = 28$ )**

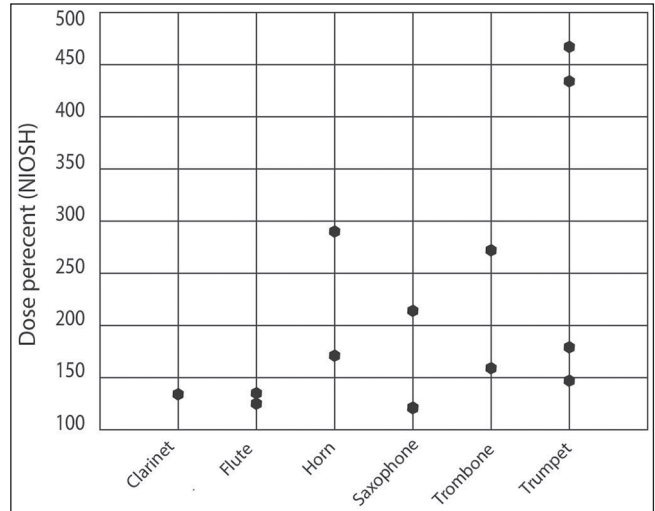


**Figure 2: Noise dose of student musicians during individual practice sessions exceeding 100% on at least 1 day ( $n = 8$ )**

of the participants' cumulative daily noise dose. There were students who exceeded 100% cumulative dose just due to exposure during large ensemble rehearsals. The cumulative daily noise dose of students who play the trumpet, clarinet, and horn came primarily from exposure during large ensembles. On the other hand, most of the exceeding cumulative noise dose of three voice students came from their exposure during their individual practice sessions. None of the students of voice exceeded 100% noise dose during large ensemble rehearsals (range of noise dose 0-59%). Nonmusic activities (library, lunch, and break) may also have contributed to overall dose. In fact, one student musician exceeded 100% noise dose during lunch.

## Discussion

This study utilized personal full-day dosimetry measurements, using NIOSH recommendations, to examine noise exposure in classical student musicians. The results show that nearly half (49%) of the student musicians exceeded a 100% noise dose for at least 1 of the 2 measurement days with nearly one in five (19%) of student musicians exceeding 100% on both days. In the current study, the sound exposure measurement represents the noise exposure of a typical college day for student musicians, which ranges from 7 to 9 h. The results of this study support the report of Miller *et al.*,<sup>[18]</sup> who measured sound exposure for a period of 4-6 h. Their findings also showed that collegiate student musicians with primary instruments such as trumpet, trombone, horn, saxophone, and drum exceeded 100% noise dose by both OSHA and NIOSH standards. The noise doses reported by Miller *et al.*<sup>[18]</sup> for different instrument players were much higher than the current study as sound exposure measurements were conducted during practice and performance at sports events (football and basketball games), which are much noisier than typical college activities. The background noise at sport



**Figure 3: Noise dose of student musicians during ensemble sessions exceeding 100% on at least 1 day ( $n = 14$ )**

events might have contributed significantly in very high noise dose reported by Miller *et al.*<sup>[18]</sup>

The OSHA and NIOSH criteria for measuring the noise exposure in the United States were originally developed for populations exposed to industrial noise. Music exposure is not as hazardous as noise exposure in industries because classical music has frequent silent periods, substantial variation in sound levels, and it may induce a toughening effect.<sup>[19]</sup> TTS due to classical music exposure is lower than TTS after industrial noise exposure.<sup>[23]</sup> Although music exposure is not as hazardous as industrial noise exposure, the higher prevalence of hearing loss in student musicians<sup>[16]</sup> and higher sound exposure levels during practice sessions<sup>[8,20-22]</sup> is a serious matter of concern.

The findings of the current study reveal the importance of conducting 2 day measurements, as most musicians have variable practice and performance schedules. Previous studies have examined musicians' sound exposure during rehearsal/performance sessions on three consecutive days or only 1 day,<sup>[12,18,20]</sup> but none have measured sound exposure throughout the day.

The next level of analysis further examined whether certain practice venues contributed more exposure than others. This revealed that one-fourth of students exceeded 100% noise dose during large ensemble rehearsals on at least 1 day, with only a small proportion (16%) of students exceeding this dose during individual practice sessions. This may be because large ensembles comprises a large number of sound sources, which increases the intensity in the room and even when the participants' section has rests, other musicians continue with the music. Moreover, the seating position in the large ensemble rehearsals may also contribute to higher noise dose measurements for particular student musicians. For example,

a student seated in front of the trumpet/horn/saxophone may be exposed to higher sound levels than other student musicians of the ensemble. Henschel and Chesky<sup>[20]</sup> demonstrated this by constant seating positions during sound level measurements for five college jazz musicians during ensemble practice over 3-day period. They found different sound exposure levels and noise doses in five different musicians in the same ensemble. In the current study, seating positions in large ensemble were not controlled as they practiced in different ensembles on different days. More students are overexposed during ensembles than individual practice.

However, three voice students exceeded 100% dose during individual practice. This finding could be attributed to two factors. One is related to smaller room dimensions and accompanying pianist during individual practice sessions. With the small room dimensions, with students facing a wall as well as facing the pianist while singing, the noise dosimeter will measure reflecting sounds from proximal walls during practice. However, in large ensembles, the practice halls are larger, and the reflecting sounds loses energy as it travels a longer distance. The second factor is that some students may have had a stronger voice. The three students, who exceeded 100% noise dose during individual practice sessions, but not in large ensemble rehearsals, may have sung with a stronger voice than their peers. The pianist who accompanied these three voice students might not have participated in this study as none of the pianist exceeded 100% noise dose. Another factor that contributes significantly to the variable sound exposure among student musicians is their schedule. Students' schedules consist of individual, small, and large ensemble rehearsals, individual practice sessions, breaks, and course work. According to Barlow,<sup>[24]</sup> undergraduate music students reported average rehearsal times of 11.5 h/week with a mean duration of 2 h 30 min per session. In another study by Miller *et al.*,<sup>[18]</sup> 15% of student musicians reported playing their instrument over 20 h/week, whereas 48% of students reported playing their primary instrument 10 h/week. The above studies do not take into account other exposures throughout the college day such as listening to music through speakers, music played by other students, and observing performances, which contribute in cumulative noise exposure.

In the current study, students showed day-to-day variability in their sound exposure. For instance, one student who plays the bassoon showed large difference in noise dose between day 1 and day 2. This was attributed to difference in schedules of 2 days; the schedule of day 1 of the bassoon student comprised university band rehearsals, secondary instrument practice, lectures, reed making, break, and ear training session whereas the day 2 schedule consisted of lecture, break, convocation, and secondary instrument practice.

Other factors that may affect the level of sound to which music students are exposed may include the selection of music,

position of student musicians in ensemble, and different techniques used to play the instrument. The music pieces practiced by students during individual and large ensemble rehearsals varied in terms of scale, quality, and loudness. Some pieces have greater sound intensity than others and we had no control over these aspects of exposure.

This is the first study to measure the level of sound exposure for music students throughout their entire college day. The results of this study provide evidence that the cumulative sound exposure in many classical student musicians exceeded the 100% noise dose and is a better representation of a student musicians' actual sound exposure than the measurements conducted in ensemble rehearsals and individual practice sessions. The findings of the study also indicate the importance of conducting hearing conservation programs in university music schools and conservatories. Hearing conservation programs can play a crucial role in the prevention of noise-induced hearing loss among faculty and student musicians. Moreover, there is a need to educate faculty and student musicians about the hazards of loud sound exposure, importance of regular hearing evaluations, safe ways of practicing music, room acoustics, and use of musician's earplugs to protect their hearing.

### Financial support and sponsorship

These data were collected with the support of a grant from the National Institutes of Deafness and other Communication Disorders (R21 DC009296-01A2).

### Conflicts of interest

There are no conflicts of interest.

### Address for correspondence:

Dr. Susan L. Phillips,  
Department of Communication Sciences and Disorders,  
University of North Carolina, Greensboro,  
North Carolina, USA.  
E-mail: [slphilli@uncg.edu](mailto:slphilli@uncg.edu)

### References

1. Lipscomb DM. Ear damage from exposure to rock and roll music. *Arch Otolaryngol* 1969;90:545-55.
2. Reddell RC, Lebo CP. Ototraumatic effects of hard rock music. *Calif Med* 1972;116:1-4.
3. Axelsson A, Lindgren F. Pop music and hearing. *Ear Hear* 1981;2:64-9.
4. Ostri B, Eller N, Dahlin E, Skyllv G. Hearing impairment in orchestral musicians. *Scand Audiol* 1989;18:243-9.
5. Størmø CC, Stenklev NC. Rock music and hearing disorders. *Tidsskr Nor Laegeforen* 2007;127:874-7.
6. Zhao F, Manchaiah VK, French D, Price SM. Music exposure and hearing disorders: An overview. *Int J Audiol* 2010;49:54-64.
7. Juman S, Karmody CS, Simeon D. Hearing loss in steelband musicians. *Otolaryngol Head Neck Surg* 2004;131:461-5.
8. Backus BC, Clark T, Williamson A. Noise exposure and hearing thresholds among orchestral musicians. In: Williamson A, Coimbra D, editors. *Proceedings of the International Symposium on Performance Science*.

- Utrecht, The Netherlands: The European Association of Conservatories (AEC); 2007. Available from: <http://www.performancescience.org/ISPS2007/Proceedings/Rows/04Backus.etal.pdf>. [Last accessed on 2016 Feb 25].
9. Gonçalves CG, Lacerda AB, Zeigelboim BS, Marques JM, Luders D. Auditory thresholds among military musicians: Conventional and high frequency. *Codas* 2013;25:181-7.
  10. Obeling L, Poulsen T. Hearing ability in Danish symphony orchestra musicians. *Noise Health* 1999;1:43-49.
  11. Patil ML, Sadhra S, Taylor C, Folkes SE. Hearing loss in British Army musicians. *Occup Med (Lond)*. 2013;63:281-3.
  12. Laitinen HM, Toppila EM, Olkinuora PS, Kuisma K. Sound exposure among the Finnish National Opera personnel. *Appl Occup Environ Hyg* 2003;18:177-82.
  13. Chesky K. Measurement and prediction of sound exposure levels by university wind bands. *Med Probl Perform Art* 2010;25:29-34.
  14. O'Brien I, Driscoll T, Ackermann B. Sound exposure of professional orchestral musicians during solitary practice. *J Acoust Soc Am* 2013;134:2748-54.
  15. Gopal KV, Chesky K, Beschoner EA, Nelson PD, Stewart BJ. Auditory risk assessment of college music students in jazz band-based instructional activity. *Noise Health* 2013;15:246-52.
  16. Phillips SL, Henrich VC, Mace ST. Prevalence of noise-induced hearing loss in student musicians. *Int J Audiol* 2010;49:309-16.
  17. McIlvaine D, Stewart M, Anderson R. Noise exposure levels for musicians during rehearsal and performance times. *Med Probl Perform Art* 2012;27:31-6.
  18. Miller VL, Stewart M, Lehman M. Noise exposure levels for student musicians. *Med Probl Perform Art* 2007;22:160-5.
  19. Rawool VW, editor. Conservation and management of hearing loss in musicians. In: *Hearing Conservation: In Occupational, Recreational, Educational, and Home Settings*. 1<sup>st</sup> ed. New York: Thieme Publishers; 2011.
  20. Henoach MA, Chesky K. Sound exposure levels experienced by a college jazz band ensemble: Comparison with OSHA risk criteria. *Med Probl Perform Art* 2000;15:17-22.
  21. Holland NV. Sound pressure levels measured in a university concert band: A risk of noise-induced hearing loss? *Update Appl Res Music Educ* 2008;27:3-8.
  22. Schmidt JH, Pedersen ER, Juhl PM, Christensen-Dalsgaard J, Andersen TD, Poulsen T, *et al.* Sound exposure of symphony orchestra musicians. *Ann Occup Hyg* 2011;55:893-905.
  23. Strasser H, Irle H, Legler R. Temporary threshold shifts and restitution after energy-equivalent exposures to industrial noise and classical music. *Noise Health* 2003;5:75-84.
  24. Barlow C. Potential hazard of hearing damage to students in undergraduate popular music courses. *Med Probl Perform Art* 2010;25:175-82.

Copyright of Noise & Health is the property of Medknow Publications & Media Pvt. Ltd. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.