Short Communication

Evaluation of Musical Conductor Exposure to Noise

Ahmed Saleh Ahmed Summan[1]

1. Faculty of Environmental Sciences – Center of Excellence in Environmental Studies, King Abdulaziz University, Saudi Arabia

This article presents a case study evaluating occupational noise exposure among musical conductors at a party center in Jeddah city. Using a calibrated noise dosimeter, personal exposure levels were measured during 8-hour rehearsals with 90 players over two days. Results showed noise levels significantly exceeded the NIOSH limit of 85 dBA, peaking at 91 dBA. Contributing factors included the number of musicians, instrument types, and rehearsal activities. This study highlights the critical importance of assessing noise exposure to protect the hearing health of conductors and musicians, ultimately fostering safer working environments in the music industry.

Correspondence: papers@team.qeios.com — Qeios will forward to the authors

1. Introduction

Noise is defined as any unwanted sound. Exposure to noise has been found to result in personal and social aspects including annoyance, stress, anger, distraction, poor speech intelligibility, anxiety, loss of productivity, tinnitus and hearing loss[1].

Several studies had investigated the occupational exposure to noise among many workers from different work sectors around the world including industries, offices, and schools. However, musical conductors were rarely investigated for their noise exposures, even though, their musical activities are responsible to produce very loud noise. For instance, a study was conducted on 18 music teachers at a public school, results showed that 78% of them were exposed to noise levels higher than 85dBA/8hr[2].

Another assessment found that one third of 17 musical instructors were at risk of exposure to high levels of noise that exceeded the limits of 85 dBA. It was found that a number of activities contributed to this high daily noise levels including group rehearsal, performance and personal practice sessions[3].

 doi.org/10.32388/LPCS07.2

Around nine music teachers had been involved in another study and were found to be exposed to unacceptable occupational noise levels during normal working days in schools. Several factors were associated with their exposures involve types of instruments they play, room acoustics (e.g. reverberation time), room design and number of students[4].

The present study evaluated the occupational noise exposure level among a conductor in a musical rehearsal hall during a full shift for two days. It also compared the results with the permitted occupational noise exposure levels by NIOSH "National Institute of Occupational Safety and Health" (85 dBA/8 hr a day) [5], and investigated the main factors contributed to the noise exposure results.

2. Materials and Methods

2.1. Study Site and

This study was conducted in a musical rehearsal hall at a medium-sized concert center (area = 800 $m^{2;}$ volume = 4800 m^3). The hall was constructed with brick walls and concrete floor covered by ceramic tiles, and the ceiling was made of acoustic tiles. There was no installation of any sound absorbing materials on the surfaces of the hall.

2.2. Study Participant/s

Measurements of noise exposure level were taken for a 46 years male musical conductor at that musical rehearsal hall for two days during periods of rehearsal. The subject voluntarily participated in this study and provided verbal consent for noise exposure monitoring. Since the study only involved non-invasive environmental measurements, formal ethics approval was not deemed necessary. Moreover, to maintain confidentiality, no personally identifiable information was collected. The subject's responses were anonymized before analysis.

2.3. Experimental Procedures for Noise Exposure Level Measurements

a) Noise exposure level, dBA

A calibrated and fully recharged noise dosimeter (CEL-350 dBadge) was used to measure the equivalent noise level (L_{Aeq}, dBA) that the teacher was exposed to during days of sampling. At the beginning of each day of sampling, dBadge was attached to the subject's shoulder within his hearing zone, turned on and starting time was recorded to sampling sheet. The device was logging noise levels during the whole shift

hours, where the subject was asked not to turn off the dBadge. At the end of each day, the dosimeter was removed by the researcher from the subject's shoulder, turned off immediately, ending time was recorded on the sampling sheet, and then taken to be connected to our lab computer to upload the stored data through special software (CEL-350db). Results were analyzed and compared with the noise exposure limit of 85 dBA/8 hours a day as regulated by NIOSH.

b) Period and Number of Participants

Measurements were performed for the whole two-day period of musical rehearsal at the musical hall, which was a total of 7 hours on day 1 and 4 hours on day 2. These specific 2 days of sampling presenting the subject regular weekly work schedule during that month as he claimed.

c) Documenting Conductor Activities

To systematically observe and record the conductor's activities during the days of sampling, a specialized daily logbook was utilized. The conductor was instructed to meticulously detail all musical rehearsal activities undertaken throughout this period. This logbook served as a comprehensive record, capturing the frequency, duration, and nature of each rehearsal session. By engaging in this self-reporting method, valuable insights into the conductor's practice habits, repertoire focus, and overall engagement in the sampling process were gathered, providing a rich dataset for analysis.

3. Results and Discussion

Figures 1 and 2 show a variation on the noise L_{Aeq} per each hour of exposure on each day. L_{Aeq} on the first day ranged between 77 dBA at the first hour of the shift to 94 dBA almost at the last hour. In addition, the minimum noise exposure levels ranged between 65 dBA to 72 dBA, and the maximum levels ranged between 86 dBA to 105 dBA.

doi.org/10.32388/LPCS07.2

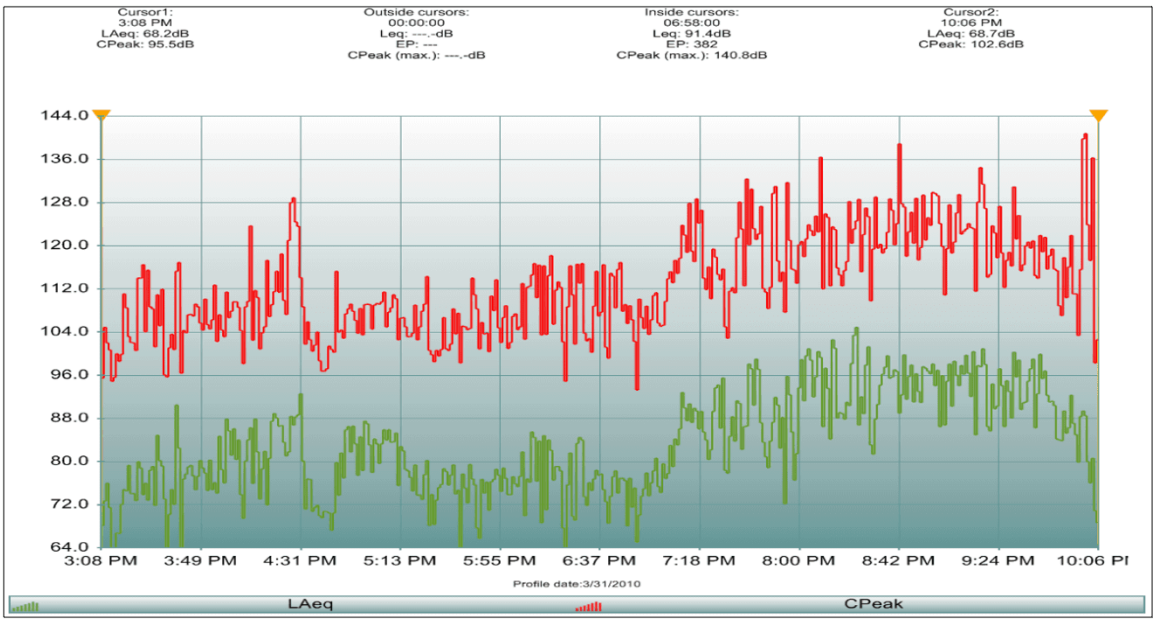

Figure 1. Measured L_{Aeq} and C_{Peak} of continues exposure to noise for 7 hours on the first day for a musical conductor during rehearsal session.

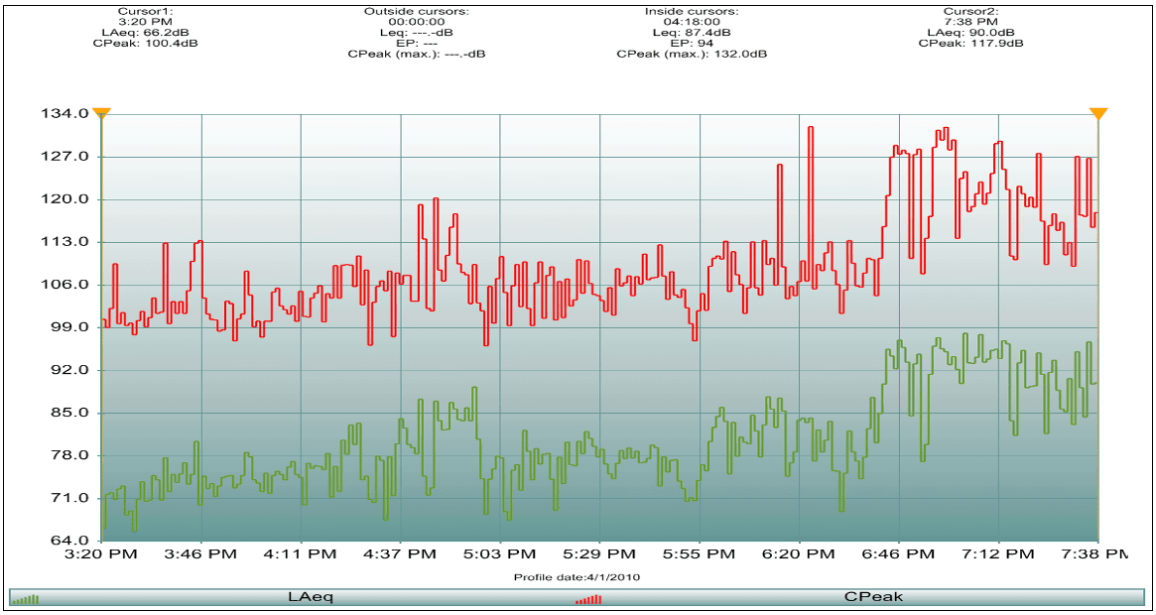

Figure 2. Measured L_{Aeq} and C_{Peak} of continues exposure to noise for 4 hours on the second day for a musical conductor during rehearsal session.

doi.org/10.32388/LPCS07.2

However, the average L_{Aeqs} on the second day ranged between 74 dBA at the first hour of the shift to 88 dBA at the last hour. What's more, the minimum levels ranged between 66 dBA to 69 dBA, and the maximum levels ranged between 80 dBA to 98 dBA. This comparison shows that the noise exposure levels on the second day were lower than those on the first day due to activities and loads as described in details in the discussion part.

Table 1 shows that on the first day the subject was exposed to an average of 91 dBA for 8 hours, which was higher than the permissible exposure level 85 dBA. However, the results of the second day showed that the subject was exposed to 85 dBA that is equal to the permissible exposure level.

These results showed that on the first and the second day, the subject was exposed to an average noise level of 91 and 85 dBA respectively. Since these values represent a single measurement rather than an estimate with confidence intervals, we acknowledge this as a limitation. However, this serves as a preliminary step in validating our research hypothesis. Future studies will incorporate broader sampling and statistical analyses to enhance the robustness of the findings.

The results of this investigation indicated differences between the two days of measuring. On the first day the equivalent noise exposure level was 91 dBA/8 hrs with a peak level of 140 dBA. This obtained value (91 dBA) is higher than the limit of noise exposure level (85 dBA), which is in agreement with the previous studies on noise exposure among musical teachers/instructors[2][3][4].

Day	Measured Lex, dBA		Calculated L_{ex}, dBA	Permitted L_{ex},8Hr/day, dBA (NIOSH)
1	L_{Aeq}	91.4	91	85
	$C._{Peak}$	140		
2	L_{Aeq}	87	85	
	$C._{Peak}$	132		

Table 1. Results of two days of noise exposure levels, dBA/8hr, for a musical conductor during rehearsal sessions in a music rehearsal hall at a concert center.

As shown in Table 2, there was a high oscillation on the noise levels during the last 3 hours (19:12 to 22:05)

of the shift. Whereas the subject was exposed to equivalent noise levels ranged between 89 and 94 dBA/1 hr. The activities logbook and observation data show that the reason for these high levels of noise was due to the generated high sound from the fully symphonic band that consisted of 90 musical players. In fact, the worker was setting and walking around this musical band while they were playing the symphony. In addition, the maximum hourly noise levels ranged between 101 and 105 dBA during this activity.

On the other hand, the subject was exposed to lower levels of sound (76 – 81 dBA/1 hr) from 15:10 to 19:11 when there was only some room settings.

Moreover, noise exposure levels didn't exceed 81 dBA/1hr during the first three hours of this shift due to the activity of the orchestra and about 4 junior brass/sax players warming up.

On the contrary, the second day of measurements reflected the situation that is much quieter than the first day. On this day the equivalent noise exposure level was only 85 dBA/8 hr which is acceptable because it's lower than the limit noise exposure level in BC (86 dBA). The fluctuations of noise exposure levels were very low during the first hour of shift (15:20-16:20) in which noise level was 74 dBA. This was a result of a minor activity which is having a meeting only with some of the musical group. Since the musical bands started to play in small groups (3-4 players) from 16:21 to 18:22, a slight elevation in noise levels began to appear (Fig.2), and the subject was exposed to 78-79 dBA.

However, during the period from 19:30 to 21:30, the noise exposure levels rose very high. Therefore, our subject was exposed to 88 dBA because of the noise generated by 30 youth players of concert band playing. These findings confirm the fact that they work directly using the sound source responsible for their own sound exposure. The types of musical instrument, the way to play it, the contemporary playing of more than one musical instrument (by teachers and students) as the type of music played, can produce sound exposure levels that can easily exceed the limits recommended by the standards with a consequent risk for NIHL [3][6][7].

Moreover, previous studies also show that orchestral musicians often encounter loud music, leading to selective hearing loss, tinnitus, hyperacusis, and diplacusis. These issues can make it difficult to distinguish changes in pitch and intensity and can significantly affect musical perception. Tinnitus and hyperacusis are among the most common ear disorders in this population [8].

Day of Sampling	Duration (hour)	L_{Aeq}, dBA	Activities	Min, dBA	Max, dBA
1	15:08-16:08	77	Orchestra warming up Junior Brass – 4 players Junior Sax – 4 players	67	90
	16:09-17:09	81		67	93
	17:10-18:10	76	Room set-up	66	86
	18:11-19:11	77	Drum rehearsal	65	93
	19:12-20:12	89	Full symphonic band (90 players)	72	101
	20:13-21:13	94		81	105
	21:14-22:05	90		69	101
2	15:20-16:20	74	Meeting only	66	80
	16:21-17:21	78	Small groups (3-4 players)	67	89
	17:22-18:22	79		66	88
	18:23-19:38	88	Concert youth band (30 players)	69	98

Table 2. Variations of a musical conductor noise dose per hour during the actual period of rehearsal for each day of measurement and the activities were presented.

While people may habituate noise exposure to some degree, the level of habituation varies among individuals, and negative health outcomes can still arise, especially with chronic exposure. Previous studies have shown that chronic exposure to excessive noise levels can lead to a range of auditory and non-auditory health issues, including hearing impairment, hypertension, heart disease, and sleep disturbance [9].

Another interesting point, the acoustic conditions for that musical hall could mostly reflect the high frequency sounds generated by the music bands. This is mainly related to reverberation of hall walls. In fact, a previous study showed that participants of musical conductors from different halls settings

identified reverberation, balance, and musician connection as the key features of concert halls. Their favorite venues, all traditional "shoebox" designs, reflected these attributes. Many conductors reported compromising their musical interpretations due to acoustic issues, with balance and dynamics being the primary concerns [10].

This might also result in bouncing more sound energy into the hall area than expected. In other words, it could amplify the levels of noise generated from music-playing activities. Which had been also approved by another study that examined the impact of hall/stage size and acoustics on noise exposure and instrument balance in seven concert halls; indicating that the acoustics of the hall can greatly increase noise exposure [11][12].

4. Conclusion

Indeed, this case study findings suggest that the investigated musical conductor was at risk of occupational adverse health effects due to his exposure to high and unacceptable noise levels.

This case study suggests that music conductors may be exposed to high noise levels in their work as reflecting some agreement with previous similar field studies. However, as this research is based on a single subject, the findings should be interpreted as preliminary. Future studies with a larger sample size are necessary to confirm whether these results are representative of the broader population of music teachers/conductors. To solve this problem, some noise absorption materials should be applied to the rare wall such as multi-resonators (absorb noise at all frequencies) or at least some porous absorbers (absorb noise at mid and high frequencies). Moreover, as the last resort, the exposed subject has better to use hearing protectors that might reduce the noise levels by about 10 dBA.

As per limitation of this study, this was a single exposure measurement for 1 subject per day (for 2 days); that couldn't involve any further statistical analysis other than what was provided for a case study.

Acknowledgments

Many thanks to the owner of the party-center and the musical conductor for their collaboration in this study.

References

1. ^Concha-Barrientos M, Steenland K, Prüss-Üstün A, Campbell-Lendrum DH, Corvalán CF, Woodward A, World Health Organization. (2004). "Occupational noise: assessing the burden of disease from work-related hearing impairment at national and local levels." World Health Organization.
2. a, bCrawford K, Fethke NB, Peters TM, Anthony TR. (2021). "Assessment of occupational personal sound exposures for music instructors." Journal of Occupational and Environmental Hygiene. 18(3):139-48.
3. a, b, cBehar A, MacDonald E, Lee J, Cui J, Kunov H, Wong W. (2004). "Noise Exposure of Music Teachers." Journal of Occupational and Environmental Hygiene. 1:243-247.
4. a, bMaffei L, Iannace G, Masullo M. (2011). "Noise exposure of physical education and music teachers." Noise & Vibration Worldwide. 42(1):9-16.
5. ^National Institute for Occupational Health (NIOSH). (2018). "Guidance & Regulations on Reducing Noise Exposure | NIOSH | CDCace Safety and Health Topic." Centers for Disease Control and Prevention. https://www.cdc.gov/niosh/topics/noise/reducenoiseexposure/regsguidance.html.
6. ^Mace ST. (2006). "A descriptive analysis of university music performance teachers' sound-level exposure during a typical day of teaching, performing, and rehearsing." In: Proceeding of the 9th International Conference on Music Perception and Cognition. Bologna; 2006. p. 271-277.
7. ^Stuart E. (1999). "Determining School Music Teacher's Noise Exposure." In: Proceeding of the NHCA's 24th Annual Hearing Conservation Conference. Atlanta; 1999. paper 007.
8. ^Rodrigues MA, Freitas MA, Neves MP, Silva MV. (2014). "Evaluation of the noise exposure of symphonic orchestra musicians." Noise and Health. 16(68):40-46.
9. ^Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, Stansfeld S. (2014). "Auditory and non-auditory effects of noise on health." The lancet. 383(9925):1325-1332.
10. ^Lehtimäki E. (2019). "The effect of concert hall acoustics on the work of a conductor."
11. ^Wenmaekers RHC, Hak CCJM, van Luxemburg LCJ. (2011). "The influence of room acoustic aspects on the noise exposure of symphonic orchestra musicians." In: 10th International Congress on Noise as a Public Health Problem; 2011 Jul 24-28. Institute of Acoustics. p. 133-140.
12. ^Gade ACS. (2015). "Classical musicians' perception of room acoustic conditions." Psychomusicology: Music, Mind, and Brain. 25(3):232.

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.