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Original Article

Evaluation of noise pressure level at mosques at the time of religious ceremonies

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ABSTRACT

Background: New technologies mark the modern world, having many positive and negative influences on societies. In spite of the comfort speakers and sound/ audio systems have brought to man's life, they have been harmful and have created noise pollution. Religious rituals, light.

Objectives: The aim of this study was to determine the level of compliance to the rules of auditory health at different religious ceremonies and centers in Mashhad of Razavi Khorasan, Iran.

Material and methods: In this descriptive-analytical study, the sample size of the research was determined through enumeration of all the active mosques of Mashhad in Iran. For determining the distribution of sound pressure level in mosques, networking method and for measuring, sound level meter (TES 1358) was utilized.

Results: The average sound pressure level during religious rituals, lectures and mourning ceremonies (chest beating) was 87.14, 90.31, and 93.91 dB in the C frequency weighing network. Comparing sound pressure level in the A frequency weighing network in the morning ceremony with the standard of the US Environment Protection Agency (EPA) and World Health Organization (WHO) showed a statistically significant difference (P-value=0.013).

Conclusions: Since religious rituals take an average time of 2 hours, audio players should be adjusted to have a sound pressure level of 80 dB. In this way, exposure this sound pressure level for 2 to 3 hours based on the standard of WHO, would be noticeably risky.

Keywords: Noise, sound, mosques, ceremonies, auditory, religious

Introduction

Mosques are religious places built and used by Muslims for saying prayers, holding public lectures, worshiping, reciting the Holy Quran and performing religious ceremonies. In addition to mosques, in official places, dorms, faculties, and hospitals, there are places called "prayer rooms" for these purposes. In order for better performance of religious ceremonies, sound systems in mosques and prayer rooms need to be at a proper level. A proper and desirable listening comprehension depends upon the interior architecture of mosques. In catholic churches, sound system is not that much important, as in all ceremonies, everybody is repeating a special prayer. However, in religious ceremonies of mosques, there is a need of high-quality level of listening comprehension and different parameters such as reverberation time, pressure level, and sound volume impact on this quality[1]. In addition to comprehension, in ceremonies like narrating Nohah (something like elegies) and Sine zani (a type of religious ceremony in Shia rituals, literally translated as "chest beating"), sound volume plays an effective role in creation of excitement. Therefore, people increase sound pressure level to achieve such goals. But the question is: how much sound pressure level is requested to provide this desirable level of listening comprehension to create excitement as well as to prevent undesirable sound effects on human health?

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Ecological pollution in three recent decades have drawn global attention more than before. Various factors may pollute the environment; one of these undesirable and unwanted factors is noise, which influences the quality of life[2]. Physiological and psychoanalytical noise-originated human responses are basically incremental, and will show up in a long period of time. Human body responses to loud, earsplitting noise are similar to human responses to certain and fatal risks. Some of the symptoms of these responses include the discharging of adrenaline hormone and a change in blood pressure and heart beat[3,4]. Other sound effects are pain[5], headache, vulnerability, exhaustion and fatigue, aggression, stress, insomnia[6] and digestion problems[7]. Human exposure to loud noise may cause definite side effects like permanent and temporary hearing loss[8] and undesirable physiological and mental effects. World health organization has estimated that, about 278 million in the world are suffering from trivial to serious auditory problems. Moreover, about 0.2 to 2 percentage points of gross national production (GNP) in developing countries are spent on noise-originated costs, and almost one third of hearing losses are due to being exposed to extremely loud noise.

Noise has indirect effects on human operation including his efficiency decline and increasing the risk of incidents and errors due to weak concentration. Fortunately, in recent years in Iran, great care has been given to noise pollution; in a way that, based on article 2 of administrative regulation regarding noise pollution prevention, from the year 2000, taking any risky actions has been forbidden[9].

Allowed limits of exposure to noise have been determined by different sources (U.S. Occupational Safety and Health Administration (OSHA) and U.S. National Institute for Occupational Safety and Health (NIOSH). OSHA has determined Permissible Exposure Limit (PEL) in 8 hours of exposure equaling 90 dB in "A" frequency weighed network and NIOSH has presented its recommended exposure level (REL) as 85dB.

These limits have been designed for preventing hearing loss for most of the workers. However, about 1 worker out of 4 workers will contract a regressive hearing loss after 40 years of exposure to permanent noise.

This level of risk in work environments is reasonable, but it is unreasonably high for the exposure of the community. For approximate protection of people against hearing loss, Environmental Protection Agency (EPA) and World Health Organization (WHO) have provided guidelines for exposure to noise. These organizations have determined average daily exposure of the community (8 hours) as 75 dB in the "A" network and average 24 hours of exposure as 70dB.

Reasonable average daily exposure for different exposure levels based on the mentioned limits is indicated in table 1[10].

WHO has introduced noise pollution in big cities as the third type of dangerous pollution after air pollution and water pollution. Noise pollution in urban areas and its side effects for the whole society have led many researches to focus on this issue in public places and clinics[4,11,12]. Mosques and churches are some noise sources in cities[13].

Noise pollution and its special effects are of importance and significance due to the frequency of religious ceremonies in the country and the attendance of different groups of people (classified based on their age, gender, health level, and individual susceptibility). Hence, reaching to a special standard of sound pressure level for implication of religious aims and provision of individual health seem essential. This study has been conducted with the aim of determining sound pressure level in religious ceremonies of Mashhad in Razavi Khorasan, Iran to have an influential and positive role in controlling the effects of the growing noise pollution in the society consulting religious and scientific activists.

Materials and Method

In this cross-sectional and descriptive-analytical study, all the mosques and active prayer rooms of Mashhad were studied on the basis of census. To determine the sound/ noise pressure level at mosques, networking method was utilized. The sound pressure level was measured during Muharram ceremonies (lecture, Madahi (singing religious poetry), Nohah, and Sine zani (translator: special types of religious mourning in Islam)), at 140 stations/ locations day and night.

The measurement of the broadcasted sound pressure level at mosques was done with TES-1356 device. In order for making sure of the accuracy of the measured results with sound measurer, they were calibrated before measurement with TES-1356. The height of sound measurement was based on the participants' auditory altitude while sitting on the floor and was about 70 cm from earth level. The proximity to the machine was about a hand's length, and the machine was located in a way that the individual's body wouldn't be a noise obstacle. For determining the frequency distribution, frequency analysis was done on the "C" weighed network. Besides, measuring total sound level at "A" network was done for determining the total exposure amount and at "C" network was done and recorded for making sure of the accuracy of frequency. At the end, the accuracy of measurement process was tested by logarithm sum of sound pressure levels in central frequencies. The logarithm sum was supposed to be close to the total measured sound pressure level in the same station and in the same weighed network. After inserting the data into the PC, data analysis was done by SPSS 16, ANOVA and T tests.

Results

According to data analysis, sound pressure levels at the studied mosques in the frequency of 500 and 8000 Hz are respectively the lowest and the highest levels. (Figure 1)

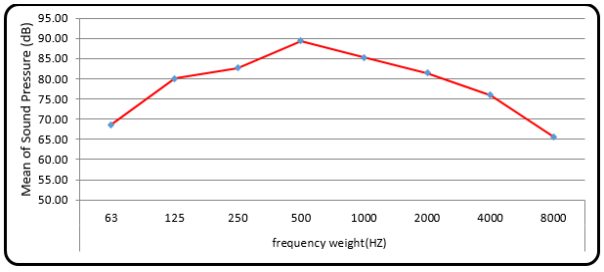

Figure 1: Average sound pressure level in central frequencies of octave speaker (C frequency weighted network)

Average sound pressure level in the C network for central frequencies of an octave-speaker in Rowdah (a kind of religious ceremony), lecture, and Sine zani ceremony was the one displayed in Figure 2. The highest sound pressure of Rowdah and Sine zani ceremonies is related to the frequency of 500 Hz. (Figure 2)

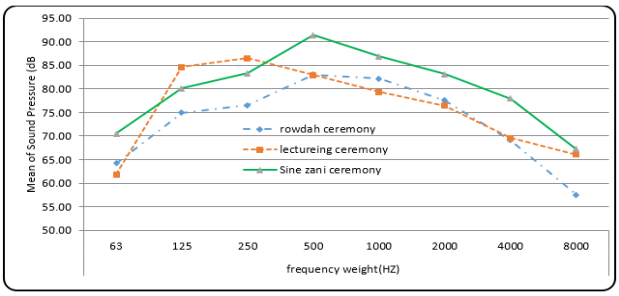

Figure 2: Comparing sound pressure level in the broadcasted octave frequencies in religious ceremonies

Average sound pressure level in Rowdah, lecture, and Sine zani ceremonies respectively equals 87.14, 90.31, and 93.91 dB in the C frequency weighed network; it is demonstrated in Figure 3. Comparing sound pressure level in the A network in lectures and Rowdahs with the standard of 50-minute-long exposure of the U.S. Environmental Protection Agency and WHO (85 dBA) didn't illustrate a significant difference, but in the case with Sine zani ceremony, a significant difference with the allowed amount of the sound pressure level is shown (Pvalue= 0.013) (Figure 3)

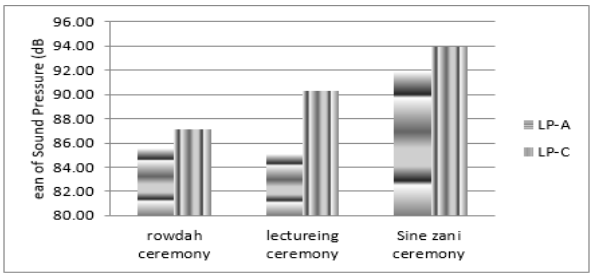

Figure 3: Average sound pressure level in two A and C frequency weighed networks in different ceremonies

Comparing sound pressure level in Rowdah, lecture, and Sine zani ceremonies in different places with 2 and 8 speakers: no significant difference was observed in sound pressure level (dBA) in Rowdah ceremony (was respectively 86.87 and 86.57 dB) with different numbers of speakers. Besides, there was no significant difference in lectures with 2 and 8 speakers, but the difference was significant in Sine zani ceremonies (table 1).

ANOVA test significantly showed the average sound level in Sine zani ceremony higher than Rowdah and lecture ceremonies; however, there was no significant difference between Rowdah and lecture ceremonies (table 2).

Table 1: Average sound pressure level at mosques with 2 and 8 speakers

Frequency weighed network	The number of speakers	The number of measured stops	Mean pressure level(dB)	Standard deviation	P value
A	8	34	94.6	5.8	0.001
	2	43	88.66	6.45	
C	8	34	96.41	5.31	0.001
	2	43	89.77	6.22	

Difference mean is significant at 0.05 level.

Table 2: Comparing the average sound pressure level in A frequency weighed network in religious ceremonies

Ceremonies	Ceremonies	Mean	SD	P value
Rowdah	Lecture	85.58	5.08	0.338
	Sine zani	91.86	7.51	0.001
Lecture	Rowdah	85.06	9.42	0.338
	Sine zani	91.86	7.51	0.046

Discussion

The results of this study show that the average sound pressure level in the A weighed network in lectures and Rowdahs was normally allowed for a period of 50 to 60 minutes and equaled 85dB. Thus, by spending this period of time and regulating sound pressure level in the limits of 85 dB in the A network, the exposure of different communities could have acceptable risk level.

Based on the gained results, the average sound pressure level in different religious ceremonies like lecture, Rowdah, and Sine zani, depends upon various factors such as sound pressure, the utilized number of speakers, area, the architecture of mosque, the material and the reverberation time. In order for relative protection against hearing loss of people, the Environmental Protection Agency and WHO, have determined definite allowed exposure limits[10].

It has been proven through frequency analysis that, sound pressure level in frequencies less than 2000 Hz, especially in the frequency range of 500 Hz, is more than 85dB. This issue is of importance since cells perceiving sound waves are on the basement membrane, and begin from the Ovale and continue up to the cochlea, well-known as organs of Corti.

Organ of Corti is more sensitive in a definite frequency zone; as it has been experienced, frequency zone of 4096 Hz is the vulnerable zone for ear and in exposure to sound tolerates the highest amount of auditory injury. So, considering that frequencies broadcasted in these ceremonies are in a zone to which auditory cells are sensitive, the allowed limits in these frequencies have been defined higher by authority organizations. Regarding the influence of religious and positive involvement of the participants in these ceremonies, a reasonable level of risk can be attributed to auditory system in lectures and Rowdahs.

But since sound pressure level in low frequencies (80 to 2000 Hz) is 80 dB, this frequency zone cannot have a reasonable level of non-auditory risk for the exposed people. Low-frequency sounds like the noise from buses and traffic which is piercing and very hard to control, create much pain in comparison to high-frequency sounds[14]. Nissenbaum has shown in his study that, people exposed to low-frequency sounds have low general health in comparison to others in a way that their sleeping has a very bad quality and during day, they are sleepy and mental condition of them are clearly worse than others[15]. Other studies have shown that, in comparison to continuous noise (sound pressure level change of less than 5 dB), interrupted noise (sound pressure level change of more than 15 dB) is more harmful and deteriorating[16,17]. Hence, owing to the fact that the broadcasted sounds in these ceremonies are classified as sounds changing over time (changes of sound pressure levels, which are between 5 to 15 dB), exposure to them is more risky.

Due to high volume of sound and the utilized systems, average sound pressure level while "Sine zani" raised to 90-92 dB in comparison to other ceremonies, and if the ceremony is longer than 15 minutes, based on the standards of the broadcasted sound[10], not only it can influence on the auditory ability of humans, but also it can imply unreasonable risk level of non-auditory problems for people, especially for sensitive ones.

In a study entitled "Traffic and Health in Crowded Places of Berlin", the amount of discharged adrenaline and noradrenaline

was investigated in 200 women of 30 to 45 years old. It has been proven that, the amount of Catecholamine is significantly higher in women whose bedrooms are across from busy and noisy streets (sound pressure level of more than 57 dB) in comparison to the control group who live in sound pressure levels of less than 52 dB[14]. Furthermore, individual differences are influential in reacting against noise. Some people have special auditory sensitivity and are not able to tolerate naturally-loud noise. Research shows that, the amount of pain and harm, the rate of heart beat, and defense reactions increase based on sensitivity to sound[14]. On the basis of the results of this study, adding to the number of speakers and incorrect installation location of them might cause a boost in the sound pressure level and a drop in the quality of listening comprehension. The most crucial parameter in creating sound quality (high listening comprehension) of reverberation time. High reverberation time results in unreasonable level of listening comprehension. On the other hand, low reverberation time causes a boring atmosphere and decreased attention of people. Thus, reverberation time for mosques is suggested as in Figures (4&5)[1].

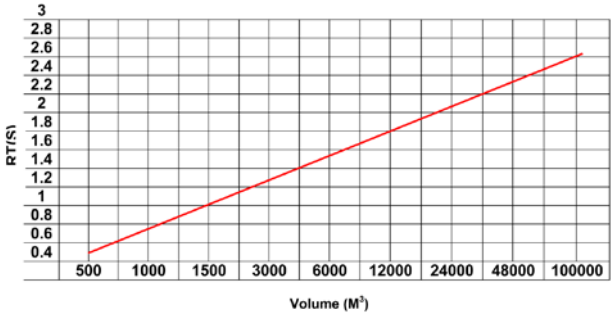

Figure 4: Recommended Reverberation Times for Different Mosque's Volumes

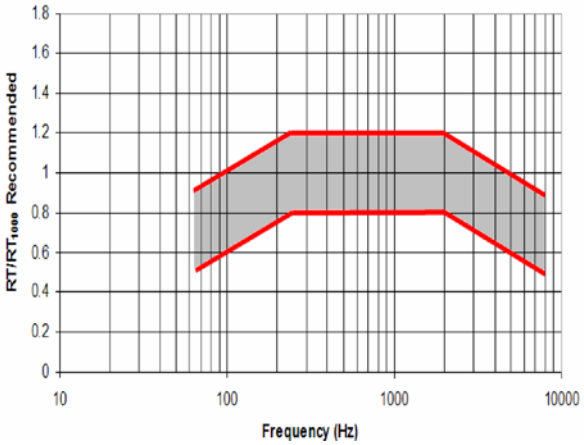

Figure 5: Tolerance Ranges of the recommended RT as a function of frequency

Conclusion

Taking into account the reverberation time in the structure of mosques not only creates good listening comprehension but also with regulating the broadcasting systems, managing the duration of different ceremonies can decrease noise-originated risks and provide people health.

Since the usual duration of religious ceremonies is up to 2 hours, with adjusting sound systems at the sound pressure level of less than 80 dB, paying attention to the time of ceremonies, revising the reverberation time of inside of building with scientific informing and the involvement of the principals of mosques, prayer rooms and amphitheaters, exposure to sound pressure level in these environments according to the standard of WHO will take 2 to 3 hours and will have reasonable level of risk.

Conflicts of interest

The authors declare that there are no conflicts of interests regarding the publication of this article.

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