

Chapter 62

The Management and Relationship Between Different Frequency Noise and Subjective Annoyance

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Abstract This paper is aimed to explore the influence of different frequency noises to subjective annoyance. In order to analyze the impact, the surveying community-citizens were divided into different groups in accordance with the purposes of the analysis, and the different degrees of the noise-influence was analyzed by contrast with different groups. The results showed that the subject annoyance was influenced by the noise and has the positive correlation with the noise level and the noise frequency, especially the low frequency noise having obvious influence on the elders.

Keywords Different frequency noise • Subject annoyance • Low frequency noise • High frequency noise • Water pump's noise • Subway' noise

Introduction

Noise is one of the four major pollutions, and it exists everywhere (Yu-jun Tian et al. 2003). The noise pollutes the environment and hazards human health (World Health Organization 1980). The high-intensity noise may induce hearing loss and the low-intensity noise may interfere with human rest, so the noise has harmful effect on the quality of human's daily life, such as the subject annoyance and sleep quality (Zhi-suo Liu et al. 2003; Gaab et al. 2008). The serious subject annoyance

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can cause sleeplessness, so assessing individual annoyance is mainly to investigate the sleep quality of the residents (Ana Lucia Rios and Geruza Alves da Silva 2005). The subject annoyance is in connection with the environment of sleeping, while the sound environment is one of the important factors. Many people have suffered from sleep disorder, because their bodies could not adapt to sound environment of their bedrooms. The sound in the bedrooms makes them uneasy, even leading to sleepless (American Sleep Disorder Association 1990; Pedemonte et al. 1997). The sound is a very complex component, which is composed of many different frequency pure tones, and different persons have different reactions to various sounds. The certain frequency noises that are sensitive to these people made them suffering sleep disorder (MuzetAlain 2007; Eberhardt and Akselsson 1987). So the high quality of sleep needs the good sound environment and to keep away the sensitive frequency noise from them.

Subjects and Methods

Subjects

For the questionnaires and investigation, we have collected 59 residents, asking them to live in the different sound environments, namely, the quiet environment, the environment with the water pump noise and the environment with the subway noise that were tested by Norsonic Type 118. The frequency spectrum data of the three kinds of noises are shown in Figs. 62.1, 62.2, and 62.3 respectively.

The investigated residents are composed of 28 males and 21 females. The eldest is 67, the youngest is 5 years old, and average age is 52.5. As to the noise levels, the quiet environment is 27–34 dB, the noise of water pump is 28–39 dB and the subway noise is 29–41 dB. As to the noise types, the quiet environment stands for no-outside noise, while the noises of the water pump and the subway represent to the low frequency noise. In addition, the investigated subjects have no disease to sleepless, and the control group and exposure group have no statistics signification ($F = 0.24$, $F = 5.27$; $P > 0.05$).

Methods

The collected data were divided into different groups in accordance with the purpose of the analysis, and after the comparison the differences of the groups were concluded. The 59 residents were divided into 3 groups according to the types of noises mentioned above. People living in quiet were in group 1 including 20 persons, the residents living with water pump noise made up group 2 including 17

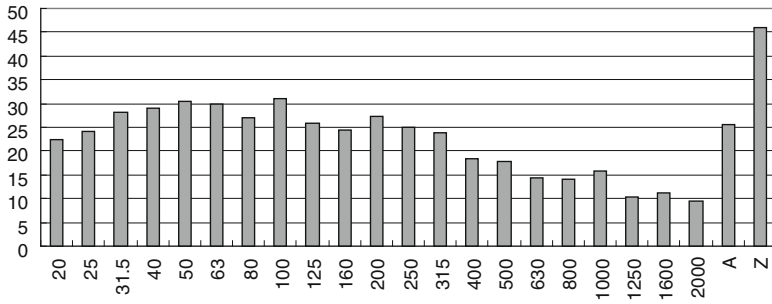


Fig. 62.1 The frequency spectrum figure of background noise in bedroom

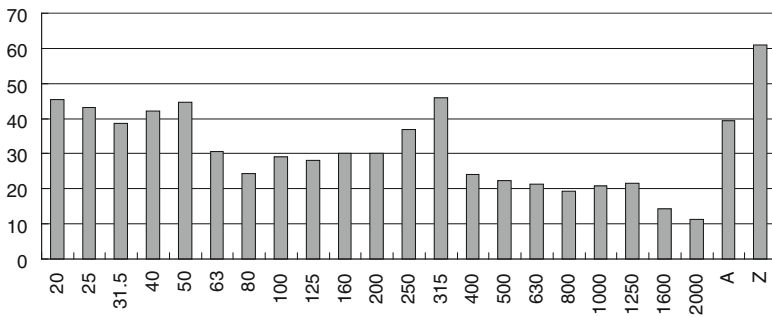


Fig. 62.2 The frequency spectrum figure of water pump's noise in bedroom

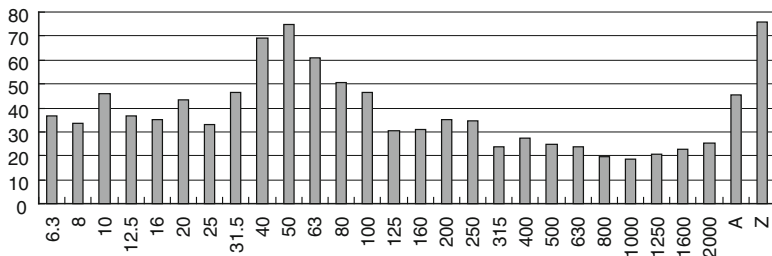


Fig. 62.3 The frequency spectrum figure of subway's noise in bedroom

persons and the rest members were in group 3 including 22 persons living with the subway noise.

Meanwhile the group 1 was also a control group, and the group 1 and 2 were known as the exposure groups. The next step is to analysis the relations between the three types of noises and subject annoyance individually.

The questionnaires were sent to the residents and collected after the subjects finished. The questionnaires were 59 in total and the investigation subjects were 59 persons, so the rates of sending and taking-back about questionnaires is 100%. With

Table 62.1 The relation between subjects annoyance and age

Age (year)	Controlled group	Exposure group	Incident rates (%)	
			Control	Exposure
~25	5(0)	7(1)	0.00	14.29
~40	6(0)	9(7)	0.00	77.78
~55	4(1)	10(5)	25.00	50.00
>55	5(2)	13(10)	40.00	76.90
Total	20(3)	39(23)	15.00	58.97

regard to the questionnaire contents, it primarily contains subject annoyance, sleep quality and other information such as age, and gender. Since the different grades of subject annoyance may cause varying influence to human health, assessing the subject annoyance was the key item to investigate sleep quality of the residents.

Results

The Relation Between Subject Annoyance and Age

Concerning the age composition of the investigated residents, the 59 people were divided into four ranges as shown in Table 62.1.

Table 62.1 explores the relationship between age and subject annoyance that the subject annoyance has declined markedly with the age increasing in the both columns of control group and exposure group. And by the comparison with the two groups, the subject annoyance of exposure group is worse than control group, which prove that the age is an important factor to influence the subject annoyance.

The Relationship Between Subject Annoyance and Type of Noise

In terms of subject annoyance, it could be divided into three levels according to the difficulties of sleep. They are Normal which means non-impacted by noise, Moderate representing interruptive but no insomnia, and Severe expressed suffering insomnia. That information was acquired by the interview and the questionnaires investigation, and after analyzing the results of statistic are shown in Table 62.2.

In Table 62.2, 17 persons of control group have normal sleep which takes the percentage of 85% while the moderate is only 15%. However, as to exposure group 1 that lived in a water pump noise environment, there are 29.41% persons' sleep been impacted by the noise moderately and 29.41% persons' sleep been severely influenced. As to exposure group 2, there are 34.36% persons' sleep been impacted by the noise moderately and 32.82% persons' sleep been severely disturbed. Through the comparison with three groups, the data figured that people living in

Table 62.2 The statistic of different subject annoyance of three groups

Group	No.	Normal		Moderate		Severe	
		No.	%	No.	%	No.	%
Controlled group	20	17	85.00	3	15.00	0	0.00
Exposure group 1	17	7	41.18	5	29.41	5	29.41
Exposure group 2	22	7	32.82	8	34.36	7	32.82
Total	59	31	52.54	16	27.12	12	20.34

Table 62.3 The relationship between different-intensify noise and subject annoyance

Group (dB)	No.	Normal		Moderate		Severe	
		No.	%	No.	%	No.	%
<30	28	21	75.00	5	17.86	2	7.14
30–35	16	6	37.50	8	50.00	2	12.50
>35	15	3	20.00	4	26.67	8	53.33
Total	59	30	50.86	17	28.81	12	20.33

the quiet environment can have a better sleep than those who were surrounded by the noise. Furthermore, the comparison with exposure group 1 and exposure group 2 indicated that the influence from the subway noise, which contained moderate vibration and was discontinuous, was more serious than the water pump noise to human health. In a word, when the noise level is certain, the noise type is an important factor to the grade of subject annoyance.

The Relationship Between Different-Intensify Noise and Subject Annoyance

Through above analysis, it is known that the subject annoyance is impacted by the age and the noise types, and the two factors impact the subject annoyance badly. Besides of the two factors, the level of noise may also have effect on sleep. In this investigation, the collected data about noise is from 27 to 41 dB, and the average sound pressure level (SPL) is 29.8 dB. In order to analyze the relationship between SPL and subject annoyance, the noise data were divided into three groups according to the different SPLs, which are shown in Table 62.3.

The Table 62.3 explicated the relationship between different-intensify noise and subject annoyance. The Table 62.3 indicated that, when the level of noise is less than 30 dB, there were 21 persons owning the normal sleep which took the percentage of 75.00%, and the moderate and the severe were 17.86 and 7.14% individually. However, when the level of noise was more than 30 dB and less than 35 dB, the number of normal sleep declined quickly to 37.5%, and the moderate and the severe raised to 50, 12.5% respectively. When the level of noise was over 35 dB, the normal decreased to the minimum which only has three persons own the normal sleep, on the contrary, the percentage of the severe sleep disorders increased to 53.33% rapidly. So the level of noise is also an important factor which impacts the subject annoyance.

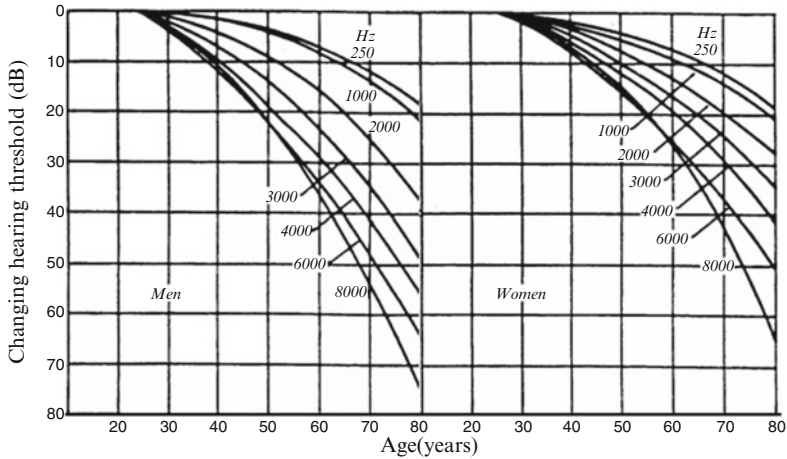


Fig. 62.4 The relation between age and hearing threshold

The High Frequency Noise and Subject Annoyance

The high frequency noise may also impact the subject annoyance. But the high frequency noise is easy to be attenuated by using the high-quality wall of windows, so the high frequency noise was not taken into account in this paper.

Conclusions

The people have different subject annoyances in various noise environments. As we all known, the serious subject annoyance can cause insomnia (Eberhardt and Akselsson 1987), while the quiet environment is prone to sleeping, but sever people know the decibel of the upper limit of the noise which the people can sleep with. To this question, we can conclude that a person's subject annoyance has a great relation with the age and the type of noise through the analysis. The people in different ages have different hearing abilities, just taking the elders for example, the elders' different frequency hearing ability will decline with the age adding graduate, but hearing ability declining is not with the same rate attenuation. In fact, the declining of hearing ability of high frequency is faster than the low frequency. This is the reason why the elders are more sensitive to low frequency noise, the relation is shown in Fig. 62.4 (GB/T 7582 2004).

On the other side, the type of noise is also an important factor that has great influence on the subject annoyance. According to the investigation, the noise can not interrupt sleep at level of 40 dB of wide frequency noise, but to the low frequency noise will interrupt people's sleep when the noise is not higher than 40 dB. The low intensity and low frequency noise interrupt people subject annoyance badly, that is why we should pay attention on it, and need to find the effective methods to eliminate it.

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