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Research Paper

Effects of Non-Acoustic Factors on Noise Annoyance in Apartment Buildings (Case Study: Aseman-E Tabriz Residential Complex)

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Abstract
Noise annoyance is a sensitive indicator of adverse noise effects and by itself means that noise affects people's quality of life. In fact, the acoustic environment has been neglected during the education of building engineers and architects relative to the thermal and lighting aspects addressed in education programs. This study aimed to investigate various non-acoustic factors on the annoyance caused by environmental noise in residential apartments. The surveys were conducted in Iran, the city of Tabriz in October and November 2019. This research is descriptive-analytical and the type of research is correlational and causal. The statistical population of this study has formed the residents of different towers of Aseman-e Tabriz Residential Complex, which was selected as the sample size by using 373 Cochran's formula. The way of selecting the sample was simple random sampling. The validity of the questionnaire has been confirmed by the professors and the reliability of the questionnaire has been obtained using Cronbach's special alpha formula for the variables in total equal to 0.857, and the variables of the situational section 0.902. Among all variables of the study, only four variables of fear with the 12.93% of variance changes, sensitivity to noise with the 11.85%, health issues of the residents with the 12.25%, satisfaction with the quality of construction, and insulation with the 12.53% were the main factors influencing.

Keywords: *Non-acoustic factors, Annoyance, Apartment, Residential buildings, Tabriz.*

1. INTRODUCTION

Human beings have endeavored to create indoor environments in which they can feel comfortable (Al Horr et al. 2016). In the developed part of the world, people spend almost 90% of their time indoors (Leech et al. 1996; Klepeis et al. 2001). Indoor conditions have serious implications for their health, comfort, and general well-being. More than half of the time spent indoors takes place in homes. It is therefore important to identify the parameters that influence the comfort of inhabitants in their homes and to see how their behavior may influence their comfort, especially considering that information on this subject is not extensive (Frontczak, Andersen, & Wargocki, 2012). Therefore, it is very important to create the right conditions for the comfort of domestic residential spaces.

Designers primarily focus on functionality and aesthetics but ignore acoustic comfort. The acoustic environment has been neglected during the education of building engineers and architects relative to the thermal and lighting aspects addressed in education programs (Croome, 1977). Building noise control may be expensive due to the lack of research on noise source, annoyance, loudness, and the resulting physical and psychological impacts on inhabitants. Architects and designers should not overlook these influences as they can jeopardize the acoustic

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environment. Many occupants are not satisfied with the indoor acoustic environment, despite the development of acoustic standards (Frontczak & Wargocki, 2011; Wang et al., 2015)

Noise annoyance affects people's quality of life (Miedema, 2007). Another definition of noise annoyance is an emotional and attitudinal reaction from a person exposed to noise in a given context (Simmons 2013). Several studies have reported that chronic noise exposure can cause annoyance, sleep disturbance, and health problems (Park, Lee, & Lee, 2017). According to (ASHRAE, 2010) guidelines, studies have indicated that a range of comfort and health-related effects has linked to characteristics of the building, which has been a growth in interest in both academic and practitioner literature on occupant health and building design.

Acoustic problems emanate from airborne sounds, outdoor noise, noise from adjacent spaces, noise from equipment, and sound of nearby facilities (ANSI, 2010). Acoustic problems could be divided into two major categories: annoyance from various noises and lack of communication privacy (Al Horr et al., 2016). Miedema argued the significant effect of urban noise (transportation) on the prevalence of noise annoyance (Miedema, 2014). It has been found that noise has not only auditory health effects (e.g., hearing loss, noise-induced hair-cell damage) but also various non-auditory health risks such as daytime sleepiness or it can impair cognitive performance in schoolchildren (Basner et al., 2014). Maschke conducted a cross-national questionnaire survey in eight European cities and found that annoyance caused by neighbor noise increased health risks in the cardio-vascular system. But noise exposure level at home is unknown because they did not perform noise measurement (Maschke, 2016).

Traffic noise (road noise, train noise, flight noise, noise of parking cars), is the most dominant source of annoyance in the living environment (Gjestland, 2021). It is well known that subjective responses to noises, such as annoyance, depend upon the type of noise (Jeon, Ryu, & Lee, 2010). There are a variety of noise sources within the indoor noise environment of residential buildings. In particular, multi-story buildings or neighboring apartment units which share a wall, ceiling, and floor structures provide structure-borne sound paths for the propagation of floor impact, airborne, and drainage noises. The propagation of these residential noise sources is a major cause of annoyance for apartment residents the percentage of multi-story buildings has steadily increased in many major cities and most residents in this type of living situation are in a constant state of annoyance due to noise disturbances (Ibid). A number of studies predicting overall annoyance from multiple noise sources have primarily been conducted in regard to outdoor transportation noises such as road traffic, train, and aircraft (Taylor, 1982; Izumi, 1988; Vos, 1992; Miedema, 2014). Orientation of windows, type of sound isolation, and floor level could affect the perception of noise. Floor level is significantly and inversely correlated with the extent of noise annoyance (Jakovljevic, Paunovic, & Belojevic, 2009). Furthermore, there is an association between traffic noise annoyance and the availability of relative quietness at the least exposed side of the dwelling (de Kluizenaar et al., 2013).

A recent study on loudness and annoyance of neighbor noise in residential buildings also reported that subjective ratings varied across housing types (Wang et al., 2015; Park, Lee, & Lee, 2017). Ryu et al. (2011) also investigated noise annoyance caused by five air-borne sources (conversation, piano, ringing telephone, music, and TV). During the experiments, the same noise variation of 30–50 dB was applied to all the noise sources. However, the present study revealed that variations of noise levels were different across noise sources. Therefore, this finding is beneficial for future studies, in particular, auditory experiments using neighbor noises (Ryu & Jeon, 2011).

Based on Lee et al. (2010), there was little effect of combined noise sources on subjective responses such as sleep quality, sleep disturbance, annoyance, and performance. But it is significant to know that irritation also depends upon the type of noise. The frequently reported annoying floor impact noise is caused by a musical instrument and children jumping, playing, and running. Flushing toilets and bathtubs are the most annoying drainage noises. Floor impact noise is the most annoying source in residential buildings followed by airborne noise, traffic noise, and drainage noise (Lee, Shim, & Jeon, 2010).

This study aimed to investigate various non-acoustic factors on the annoyance caused by environmental noise in residential apartments. In other words, the main question of the present study is what are the non-acoustic factors affecting the annoyance index in residential apartments and complexes?

2. MATERIALS AND METHODS

A. Sample

The surveys were conducted in Iran, the city of Tabriz in October and November 2019, and 373 questionnaires were completed and collected. As listed in Table 1, 64.8% of the respondents were female and 35.2% were male. Most participants

(84.9%) were in their 20s, 30s, or 40s, and approximately 83% were educated to university degree level or higher. In addition, more than half of the participants were married (66 %) and most of them were homeowners (71.7%).

Most residents (88.6%) lived in these homes for between 1 and 10 years. And about half (47.1%) of the people had between 2 and 5 hours of work (mental or physical) at home. And about half of the people surveyed (47%) live in houses with 110 to 150 square meters. Half of the households are between 3 and 4 people, and the number of couples or single people is about 37%. The length of stay at home is approximately equal to three groups.

B. Measurement (Overviewing the Variables)

Since self-reported annoyance has long been investigated as one of the major non-auditory responses to noise, annoyance was measured along with affective responses in a laboratory experiment with varying noise levels (Park, Lee, & Jeong, 2018). There are two important factors in the appearance of annoyance regarding the relationship between noise and annoyance: acoustic factors and non-acoustic factors (Premat 2005). This article focuses on non-acoustic factors. There are many studies in the literature on one or several of these factors, whose effects on annoyance have been demonstrated, but only a small number of authors have focused on the cumulative effect of many variables. These include Moch-Sibony (Moch-Sibony 1980), Fields and Walker (Jamea M Fields & Walker, 1982), Job (1988), Fields (James M. Fields, 1993) and Miedema and Vos (Miedema & Vos, 2002). Another research has conducted descriptive analysis, in this paper the widespread of annoyance to noise and road traffic intensity at a residential address is investigated among the adult population of Germany and to what extent annoyance and exposure differ in respect to socioeconomic status and housing conditions of the study participants (Lausmann et al. 2013).

Table 2. Participants' Personal Characteristics

		N	%
Gender	Male	154	41.5
	Female	217	58.4
Age	Teens	49	13.2
	20s	91	24.5
	30s	119	32.1
	40s	56	15.1
	50s or older	56	15.1
Education	High school or equivalent	63	17.0
	Studying at a university or college	98	26.4
	University or college graduate	147	39.6
	Postgraduate or above	56	15.1
Marital Status	Married	245	66.0
	Single	119	32.1
	Divorced, widowed, etc.	7	1.9
House ownership	Owned	266	71.7
	Rented	105	28.3
Length of residence (year)	1 to 10 years	329	88.6
	More than 10 years	42	11.4
Working time at home (h)	1 to 4	126	33.9
	2 to 5	175	47.1
	6 to 9	63	19.0
Apartment size (m^2)	110 to 150	175	47.1
	151 to 190	133	35.8
	191 to 230	63	17.1
Number of dwellers	1 – 2	140	37.7
	3 – 4	189	50.9
	5 – 6	42	11.4
Duration of stay at apartment at day (h)	1 to 4	119	32.0
	2 to 5	140	37.7
	6 to 9	112	30.3

Other research efforts have been made to simulate and measure the sound transmission loss of building components and to develop related metrics and single-number quantities. The effectiveness of the design action has been assessed through site measurements and occupant surveys (POE) focusing on the self-reported evaluation of noise levels and sound privacy (Torresin et al., 2020)

Human-related factors significantly influence noise annoyance (Della Crociata, Simone, & Martellotta, 2013). Perceptions of the same indoor environment will vary among different building users. Gender, education level, age, and type of work are correlated with the perceptions of indoor acoustic quality (Huang et al., 2013). Many social factors may affect annoyance reactions and personal attitudes to noise and its sources may influence noise annoyance (Rozzi et al., 2021; Peddie & Soligo, 2020; Shwetha & Dhariwala, 2021)

General negative attitudes toward the acoustic environment were shown to increase noise annoyance (Paunović, Jakovljević, & Belojević, 2009). The loudness of noise is objectively measurable with the appropriate equipment, but the annoyance to occupants cannot be measured directly (Müller & Möser, 2012). Generally, specialists agree to classify these non-physical factors in three main basic categories: attitude variables, socio-demographic variables, and situational variables (Premat, 2005).

Some researchers conducted meta-analyses to investigate the possible systematic effects of non-acoustical factors on noise annoyance. It was found that fear has a very large impact on annoyance. Persons who experience fear related to the transportation that causes the noise, report higher annoyance compared to persons who do not experience such fear. Studies have shown that the annoyance of this group of people is greater than that of others submitted to equal noise levels but who are not afraid of any eventual danger linked to the noise (Premat, 2005). The effect of fear on annoyance is found for all three modes of transportation, but it appears that only few persons associate high fear with railway traffic (James M. Fields, 1993; Miedema & Vos, 2002).

Another important factor is noise sensitivity. The perceived annoyance of noise has a great difference among individuals with different noise sensitivity (Di et al., 2022). The effect of noise sensitivity on annoyance is reduced only very little if age is also taken into account. Demographic factors are much less important than fear and noise sensitivity. Noise annoyance is not related to gender, but age has an effect on noise annoyance (James M. Fields, 1993). The influence of noise sensitivity on noise annoyance is strong (Miedema and Vos 2003). In most research, noise sensitivity was measured with the Weinstein's Noise Sensitivity Scale, and Logistic Regression Analysis was used to assess the impact of noise sensitivity on non-auditory health (Stošić et al., 2020). sensitivity to noise is one of only two really important factors in the reaction or response to noise (Job 1988). apart from the pressure level. Several authors show that noise sensitivity and fear of the noise source are the most important non-acoustical factors that influence exposure relationships (Guski 1999; Miedema and Vos 1998; Job 1999)

The attitude of the subject towards the sound source or the cause of noise also constitutes an important annoyance parameter: whether the subject has the possibility of protecting himself from the noise in any way at all or of defending himself, or of going to court, etc. (Hellmann, 1996). Another parameter is the subject's activity during exposure: oral communication (Widmann, 1996), relaxation, tasks requiring an intellectual concentration, listening to the radio or TV, etc. (Berglund, 1998; Schulte-Fortkamp, 1996).

The next factor is the perception of the neighborhood, the place in which people live. Annoyance increases if the characteristics of the neighborhood are such that noise is felt in a negative way, this being apparently linked more to the direct environment and to the neighbors than to the quality of public services (Langdon, 1976; Bertoni et al., 1993). Studies have also shown that individuals who believe that their health can be affected by a certain source of noise are more annoyed by this source of noise (Nelson & Nelson, 1987).

Many studies have dealt with this large category of important factors mentioned above in the appearance of annoyance: socio-demographic parameters include gender, marital situation, size of household, education level, social status, income, age, length of residence, type of home, type of occupancy (owning or renting), as well as situational variables which can be linked to them, such as time spent at home, soundproofing, etc. (Premat, 2005).

This research is descriptive-analytical. The type of research is correlational and causal. In this research, the data collection method for answering the questions has been done in both documentary and survey forms. In the library studies section, through reviewing written sources including books and articles, factors affecting the annoyance, it was examined that the tools used in the survey method of the questionnaire were of the researcher type and were of the five-choice Likert scale. The statistical population of this study has formed the residents of different towers of Aseman-e Tabriz Residential Complex, which was

selected as the sample size by using 373 Cochran's formula. Simple random sampling was used for selecting the sample. The sample was selected from the residents of the apartments in the complex.

The independent variables used in the study include 8 variables in the form of two main components, the attitude components (5 variables) and situational components (3 variables). The dependent variable of this study is the amount of non-acoustic effects of noise annoyance in apartment buildings. The validity of the questionnaire has been confirmed by the professors and the reliability of the questionnaire has been obtained using Cronbach's special alpha formula. The variables of the orientation section in total equal to 0.857, and the variables of the situational section was 0.902. Table 2 shows the variables used in this study.

Data analysis from the questionnaires was performed at two levels. The level of data analysis is related to the descriptive findings of the research, which included the frequency distribution of responses, mean, standard deviation, and the percentage of respondents in terms of personal features of occupants such as gender, age, education, marital status, house ownership, working time at home (h), the apartment size (m^2), number of dwellers, and duration of stay at the apartment at day (h).

The next level of data analysis consisted of inferential studies using tests such as factor analysis, multivariate regression tests, and step-by-step structural equations. The validity of the questionnaire was well obtained based on the opinions of experts and the reliability of the questionnaire was calculated using Cronbach's alpha test equal to 0.886. Data analysis was performed in SPSS software environment.

Table 3. Variables Used in the Study

Components	Variables	Questions
Attitude variables	Fear	Your fear of noise can cause annoyance.
	Noise sensitivity	Your sensitivity to noise can cause annoyance.
	Attitude of the subject towards the sound source	Your personal tendencies (a negative or positive mentality relative to the types of noises you hear) play an important role in your annoyance.
	Subject's activity	Your annoyance is more when you're working (Intellectual or Physical) at home.
		When you're resting (watching TV or …) at home Your annoyance is more.
	Health issues	You are more likely to be harassed when you feel the sound is harmful to your health.
Situational variables	Time spent at home	Most of the annoying noises are annoyed you throughout the day or night.
	Distance from noise	Most of the annoying noise sources that bother you are far away from you.
		Most of the annoying noise sources that bother you are very close to you.
	Sound insulation of building's elements	Are you satisfied with the sound insulation status of your unit?

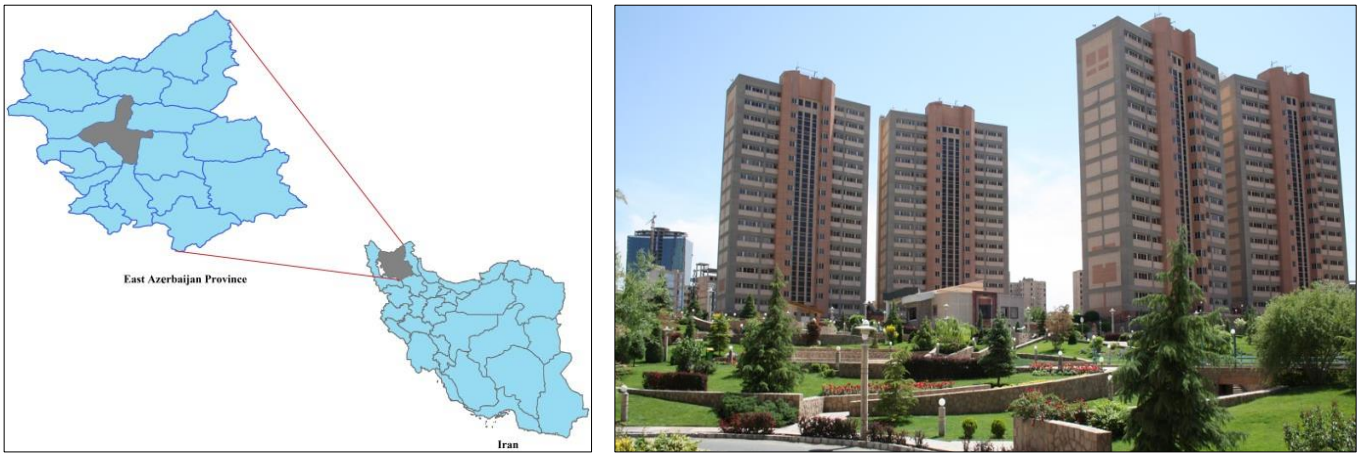

Fig 1. Maps and Photo of Aseman-e Tabriz Residential Complex, Tabriz, Iran

Aseman-e Tabriz Residential Complex was built in the form of sixteen 18-story towers in 1999 and has 928 residential units with a minimum area of 110 and a maximum of 230 square meters. This residential complex has facilities such as a lobby, a meeting hall and a private courtyard for the residents of each block, panoramic elevators, beautiful green space, children's sports fields, a unique recreational and sports complex with flagship architecture, swimming pool, sauna and Jacuzzi, gym, kindergarten, and adjacent shopping center of the complex are among the most significant mass production projects in Tabriz.

3. DISCUSSION AND RESULTS

In the first step of implementing the factor analysis model, all participants in the interview (373 people) entered the analysis. The analysis of the data obtained from the implementation of the factor analysis model is as follows (Table 3).

- The first factor, fear, itself, which is presented as a variable, with a specific value of 7.523, can explain 12.93% of variance changes. It seems that this factor is one of the most important factors influencing the annoyance index of noises, which also affects the sensitivity to noise.
- The next factor, sensitivity to noise, which is itself a variable and has no subset of factors, with a specific value of 6.985 can explain 11.85% of variance changes, which has a significant impact on the rate of annoyance index.
- The next factor Attitude of the subject, which is psychologically measured and requires further in-depth research, with a specific value of 4,288 can explain only 8% of variance changes compared to others in which the numbers are not significant.
- The forth Factor, activity, is relatively important, this factor is analyzed in three modes of mental or physical work, rest (watching TV, etc.), and sleep. In total, this factor, with a specific value of 5.215, can explain 9.06% of variance changes.
- The next factor, the health of individuals, which itself is divided into variables such as worrying about physical health, mental health issues, psychological effects and concern for deafness, was able to explain the third record in terms of annoyance total index with the ability to explain 12.25% of variance changes.
- The next factor is the time the recipient spends at home, which is not very valuable in the analysis of this section. Also, being day or night has a big effect on the amount of annoyance caused by noise, which is discussed in the following sections. This factor with a specific value of 3.986, can explain 7.75% of variance changes.
- The next factor, distance from the source, also includes two variables of near and far noises (caused by internal factors in the residential complex, such as the noise of neighbors, talking to people, etc. and remote noise caused by traffic Street or construction in the neighborhood) with a special value of 4.056 can explain 9.46% of variance changes.

Table 3. The Final Values Extracted for the Main Factors Influencing the Amount of Noise-induced Annoyance in the Exploratory Factor Analysis Model

Number	Factors title	Collective Variance (%)	Special Amount	Variable
1	Fear	12.93	7.523	Fear
2	Noise sensitivity	11.85	6.985	Sensitivity
3	Attitude of the subject	8.53	4.288	negative or positive mentality
4	activity	9.06	5.215	Working (intellectual or physical) Resting Sleeping
5	Health issues	12.25	5.841	Worry about physical health Mental health Psychological effects Concern for deafness
6	Time spent at home	7.75	3.986	Noise during the day Noise during the night
7	Distance from source	9.46	4.056	Close noise sources (noise of neighbors, …) Remote noise sources (traffic, construction, …)
8	satisfaction	12.53	6.135	The quality of housing construction (interior walls) Behavior of other residents Sound insulation Sealing doors and windows

• The last factor that refers to people's satisfaction with variables with a specific value of 6.135 can explain 12.53% of variance changes, which is the second most important in terms of importance in the list of variables. Finally, from a total of 18 different variables or modes in the study of the annoyance caused by disturbing noises in residential complexes, it can be said that all the variables in question can explain 84.36% of the total variance changes.

To analyze the effectiveness of each of the factors affecting the annoyance index caused by noises in residential complexes, a multivariate regression test has been used. The results of the regression test on the highest correlation between the factors affecting the annoyance are obtained according to Table 4. Based on the results of the regression test, it shows that among all the mentioned variables, fear, satisfaction with the physical condition of the desired location, health issues, sensitivity to noise in order of numbers 0.548, 0.466, 0.421, 0.389 are in the first to fourth priorities, respectively. These four groups of variables include the ability to explain 49.56% of total variance changes. The amount of beta also indicates that in explaining the factors affecting the annoyance caused by the noise, other components were not examined according to the nature and purpose of this study (Table 4)

Using the multivariate regression test, the relationships between each of the variables mentioned in Table 4 are examined. It is noteworthy that the factors of fear and sensitivity have no subsets and among the four variables of the study that have high scores, the factors of satisfaction and health are examined as shown in the following table.

According to table 5, the results of the regression test shows that among the variables related to resident satisfaction, it is clear that the main factor is the behavior of other neighbors with a coefficient of 0.643 that has the most positive effect. This could be due to the high culture of the residents, who are careful at different times of the day and night since their noise can prevent other neighbors from calming down. At the next level, the quality of construction in terms of inner walls is significant and can satisfy residents. However, insulation and sealing of doors and windows are not acceptable to the residents in the current situation and this factor is due to the old construction technology in this field. Finally, technical issues on noise insulation are matters of dissatisfaction among the residents.

The results of the regression test for the variables related to health issues are obtained in the following table.

Table 4. Results of Regression Test on the Relationship between Audience Demographic Characteristics and Noise Level

Variables	R	R^2	justified R^2	F	Beta	t	p
Fear	0.625	0.548	0.526	6.70	0.144	0.25	0.000
satisfaction	0.533	0.466	0.451	5.52	0.130	3.88	0.000
Health issues	0.501	0.421	0.393	5.47	0.118	4.89	0.000
Noise sensitivity	0.478	0.389	0.365	4.35	0.109	2.75	0.000

Table 5. The Results of Regression Test regarding the Role of Satisfaction Factor in the Noise Annoyance Index

Variables	R	R^2	justified R^2	F	Beta	t	p
The quality of housing construction (interior walls between units)	0.588	0.560	0.512	4.12	0.121	0.259	0.000
Behavior of other residents	0.685	0.643	0.589	3.52	0.152	3.25	0.000
Sound insulation	0.054	0.24	0.142	3.36	0.147	3.36	0.045
Sealing doors and windows (outside noise)	0.096	0.075	0.060	3.45	0.162	3.41	0.394

Table 6. The Results of Regression Test regarding the Role of Health Issues in the Noise Annoyance Index

Variables	R	R^2	justified R^2	F	Beta	t	p
Worry about physical health	0.421	0.378	0.345	2.63	.156	3.38	0.000
Mental health	0.151	0.132	0.114	2.17	.119	3.52	0.001
Psychological effects	0.047	0.030	0.017	2.62	0.131	3.41	0.041
Concern for deafness	0.423	0.400	0.038	2.36	0.125	2.63	0.000

According to Table 6, analysis of the results of the regression test on the role of health variables in the rate of noise-induced annoyance shows that, in this case, out of four different variables, being concerned about physical health with 0.378 and about hearing loss with 0.400 have the highest impact on the noise-related annoyance that should be considered by other researchers in this field.

Finally, the correlation between demographic and personality factors such as age, gender, level of university education, marital status, ownership of the house, and three main variables was examined. These three variables are fear, sensitivity to noise, and satisfaction with the current situation. The result of the correlation between these parameters can be seen in the following table:

As can be seen in the above table, there is no relationship between any of the mentined factors. That is, the main indicators influencing noise-related annoyance (fear, sensitivity to noise, and insulation quality of residential units) are not related to personal and demographic factors such as age, education, and so on.

Table 7. The Results of Correlation Test between Three Main Variables and Demographical Information

		age	gender	education	Marital status	Ownership	Fear	Sensitivity to noise	Satisfaction
age	Pearson Correlation	1	-.121	.622**	-.382**	-.276*	-.096	-.199	-.223
	Sig. (2-tailed)		.394	.000	.005	.045	.492	.158	.116
	N	373	372	372	373	373	373	372	371
gender	Pearson Correlation	-.121	1	.158	.003	.202	-.282*	-.194	-.105
	Sig. (2-tailed)	.394		.264	.984	.152	.043	.174	.467
	N	372	372	372	372	372	372	371	370
education	Pearson Correlation	.622**	.158	1	-.398**	-.272	-.163	-.156	-.347*
	Sig. (2-tailed)	.000	.264		.003	.051	.248	.275	.013
	N	372	372	372	372	372	372	372	370
Marital status	Pearson Correlation	-.382**	.003	-.398**	1	.131	.278*	.225	.237
	Sig. (2-tailed)	.005	.984	.003		.348	.044	.109	.095
	N	373	372	372	373	373	373	372	371
Ownership	Pearson Correlation	-.276*	.202	-.272	.131	1	-.033	-.197	.150
	Sig. (2-tailed)	.045	.152	.051	.348		.815	.161	.294
	N	373	373	373	373	373	373	372	371
Fear	Pearson Correlation	-.096	-.282*	-.163	.278*	-.033	1	.549**	-.011
	Sig. (2-tailed)	.492	.043	.248	.044	.815		.000	.940
	N	373	372	372	373	373	373	372	371
Sensitivity to noise	Pearson Correlation	-.199	-.194	-.156	.225	-.197	.549**	1	.046
	Sig. (2-tailed)	.158	.174	.275	.109	.161	.000		.749
	N	372	371	371	372	372	372	372	371
Satisfaction	Pearson Correlation	-.223	-.105	-.347*	.237	.150	-.011	.046	1
	Sig. (2-tailed)	.116	.467	.013	.095	.294	.940	.749	
	N	371	370	370	371	371	371	371	371

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4. CONCLUSION

As can be seen in the discussion section, the variables considered in Table 3 do not all have a large effect on the amount of noise-induced annoyance in the residential environment. The independent variables used in the study include 8 variables in the form of two main components, the attitude components (5 variables) and situational components (3 variables). The dependent variable of this study is the amount of non-acoustic effects of noise annoyance in apartment buildings. The validity of the questionnaire has been confirmed by the professors and the reliability of the questionnaire has been obtained using Cronbach's special alpha formula for the variables of the orientation section in total equal to 0.857, and the variables of the situational section 0.902. Table 2 shows the variables used in this study. Among all variables of the study, only four variables of fear with the 12.93% of variance changes, sensitivity to noise with 11.85%, health issues of the residents with 12.25%, satisfaction with the quality of construction and insulation with 12.53% are the main influencing factors.

According to Table 4, the amount of beta also indicates that in explaining the factors affecting the annoyance caused by the noise, other components were not examined according to the nature and purpose of this study. In this paper, according to the findings, it is found that fear is the main factor affecting the extent of noise-induced annoyance which is consistent with the results of other studies in this field (James M. Fields, 1993; Miedema & Vos, 2002; Premat, 2005). According to the findings of the study, noise sensitivity is the second important factor on the annoyance index which is adapted with other studies in this field. Health issues and satisfaction (construction quality of building and the quality of sound insulation) are among other important variables in this study (Hongisto, Makila, & Suokas, 2015; Dinc, Özbilen, & Bilir, 2014; Urban & Máca, 2013).

According to Table 5, the results of the regression test shows that among the variables related to resident satisfaction, it is clear that the main factor is the behavior of other neighbors with a coefficient of 0.643 that has the most positive effect. This could be due to the high culture of the residents, who are careful at different times of the day and night that their noise can prevent other neighbors from calming down. At the next level, the quality of construction in terms of inner walls is significant and can satisfy residents. However, insulation and sealing of doors and windows are not acceptable to the residents in the current situation and this factor is due to the old construction technology in this field. Finally, technical issues on noise insulation are matters of dissatisfaction among the residents.

According to Table 6, analysis of the results of the regression test on the role of health variables in the rate of noise-induced annoyance shows that in this case, out of four different variables, being concerned about physical health with 0.378 about hearing loss with 0.400 have the highest impact on the noise-related annoyance that should be considered by other researchers in this field. Finally, the correlation between demographic and personality factors such as age, gender, level of university education, marital status, ownership of the house, and three main variables was examined and there were no relationships between demographic and personality factors with fear, sensitivity to noise, and the satisfaction level of the apartment which is adapted to other researches (Miedema & Vos, 2002; Park et al., 2016)

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