Results of a survey used to evaluate noise annoyance as part of the noise action plan of León (Spain)

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ABSTRACT

The European Directive 2002/49/CE aims to establish a common approach intended to avoid, prevent or reduce the harmful effects, including annoyance due to exposure to environmental noise. Noise not only has negative effects on our health, it modifies our social behavior and causes annoyance.

A survey has been designed to analyze the annoyance due to noise pollution in the city of León. (~ 132,000 inhabitants). It was conducted to 509 inhabitants of the whole city and contains a series of questions that can bring some answers in order to meet the requirements set by the Action Plan.

The present study shows that more than half of the population of the city is annoyed by both indoor and outdoor noise. In this sense, the exterior sources that causes more annoyance among people are voices and motorcycle traffic. The study reflects that in an area which does not exceed the noise limits, people can perceived as annoying those levels and vice versa. It also shows that the perception of noise as annoying varies depending on age.

Key words: urban noise, noise annoyance, survey

1. INTRODUCTION

Nowadays the human activity, the increasing size of the cities, the industrial development, and, in general, the urban life, has led to increased sounds sometimes perceived as unwanted noise. We have to mention that numerous studies have shown that there are many negative impacts of noise, including physical and psychological problems on people [1, 2].

At the present time Europe is under a common framework in relation to noise. The European Directive on Environmental Noise (END) [3], states the need to develop noise maps and noise action plans for agglomerations, focusing on sources like traffic, railway, aircraft and industrial noise. With this tools we will be able to know the number of exposed people to different noise levels. In relation with the action plans, the END establishes the need to develop them to manage noise issues and effects. To this end, specific measures will be established, especially in the most important areas in accordance

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with noise maps.

Since the study of noise pollution depends not only on quantitative noise mappings [4, 5, 6], we must carry out a survey to study the perception of sound and noise annoyance, the effects of it, among others. Many studies have been developed related to noise annoyance and its effects [7, 8, 9, 10, 11].

For the development of this survey, studies have been used as base model [9, 12, 13]. To avoid a bias [10], it was introduced as a survey related to environmental impact. As integral parts of the survey, some data blocks were developed relating to demographics, environmental characteristics and satisfaction with their surroundings, noise perception of its streets and the city, noise sources in its environment and noise annoyance, pleasant sounds, noise effects, measures taken against noise and possible future measures, characteristics of their home, complaints made and received, among others.

The survey was carried out among 509 inhabitants with more than 1 year residence in the current home. The sampling was stratified in the eleven districts of the city, being the most populous the 3rd district, while the least populated is the 8th district.

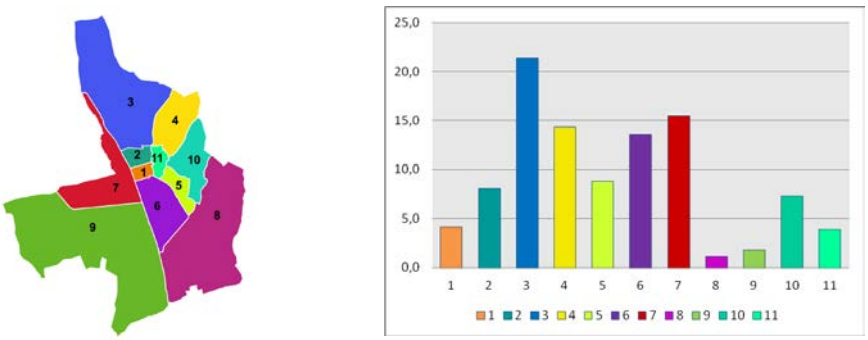

Figure 1 - Districts of the city of León and surveys distribution among the districts

2. ANALYSIS RESULTS

2.1 Housing characteristics and general data of respondents

The mean age of the respondents is 42 years old. It was found that the overall correlation between the distribution of the population of León population and the sample distribution depending on the age is quite good. About the distribution by sex, 34% are men and 59% are women (7% did not answer to this question). Average age years living in the same home is 14,7 years. Also, 77% of respondents live in a flat and 71% of the respondents are homeowners.

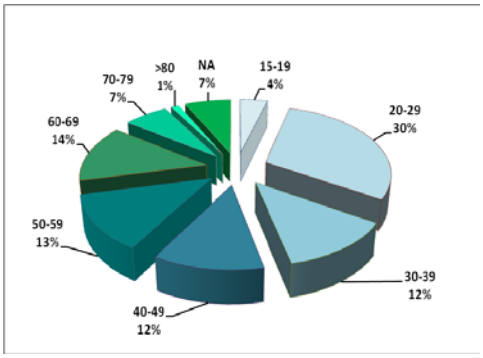

Figure 2 - Sample distibution according to age

2.2 Exposed population and noise annoyance

In order to make an assessment of noise annoyance among people, there were a series of questions based on a qualitative scale, which has been linked to a quantitative scale to carry out the analysis. The expressions used for the survey were the ones established in the Spanish language by García, et al [10]. A series of information was obtained from the survey with this scale. To help us with a future comparative analysis, although the relation is not straight, we assumed scores 5 and 4 as people highly annoyed [7, 12, 14].

Table 1 – Assessment scale

5	Extremely
4	Very
3	Moderately
2	Slightly
1	Not at all

Around 30% of the population of the city is highly annoyed by noise in the streets. If we refer to the percentage of population exposed to noise above the limit values and the percentage of people highly annoyed by noise in the street, there is a data connection in the day period, around a 30% for both cases.

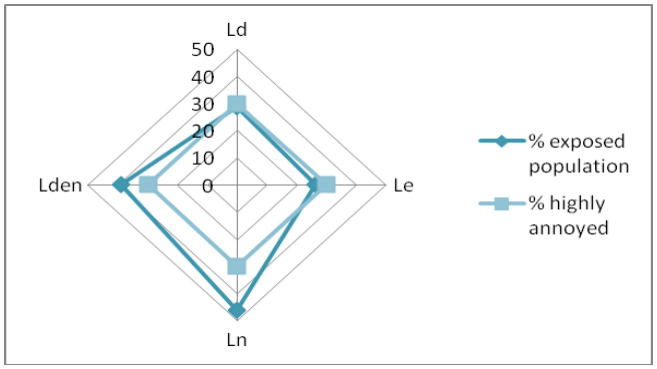

Figure 3 – Relation between people highly annoyed by noise in the street and people exposed to noise above the limit values

The districts with the highest percentage of people affected by noise for all time periods, are districts 1 and 2. This is because such districts encompass the city center with great activity, mainly road traffic, being the district number 2 the most dense (20,1 inhabitants/km^2), while district 1 ranks third (19,9 inhabitants/km^2).

Table 2 – Districts population exposed to high noise levels - noise annoyance

District	Ld		Le		Ln		Lden		% of people highly annoyed with noise in the street
	>65 (dBA)	% related to district population	>65 (dBA)	% related to district population	>55 (dBA)	% related to district population	>65 (dB)	% related to district population	
1	**2429**	**46,2**	**2273**	**43,4**	**3533**	**66**	**3209**	**60,4**	28,6
2	**5680**	**54,8**	**5327**	**51,2**	**4583**	**82,7**	**7315**	**70,3**	18,4
3	6974	24,3	6198	21,7	11494	40,3	9766	34,4	34,7
4	4033	21,7	3763	20,7	8744	47,5	6168	33,2	20,5
5	3270	28,4	2785	24,3	4783	41,6	4184	36,8	34,1
6	7522	42,7	7113	39,9	11152	62,7	9513	53,4	33,9
7	4279	21,1	3763	18,5	9655	48,3	6326	31,7	**37,3**
8	538	20	512	20	694	28	607	24	0
9	1150	28,2	1019	25,7	1745	45	1460	38,5	22,2
10	1599	17,2	1494	16,1	3251	35,6	2143	23,7	27,8
11	460	9,5	439	9,5	1314	25,1	902	18,9	**38,5**

However, these districts are not those with greater annoyance among the population. As we can see, overcoming threshold levels stipulated by the END, does not imply that noise is perceived as a nuisance, and vice versa. It means that in an area which does not exceed the noise limits, people can perceived as annoying those levels. The citizen annoyance due to noise depends on other factors, not just on objective data as the one obtained on noise maps based on dB [4, 5, 6].

In this case the districts with greater annoyance are the 11th district, with almost 40% of the population and the 7th district with 37%. In the case of the 11th district, which is a pedestrian area, the noise of other sources is present, especially at night: music, voices of people, intense activity during loading and unloading, etc. In the 7th district is an outlying district where the urban morphology with high buildings and narrow streets (canyon effect), can lead to generate more annoyance among citizens.

2.3 Noise annoyance and noise from outside and inside buildings

People who experience discomfort due to external noise are 59% of the total, while for interior noise are the 55%. Therefore, we can say that more than half of the population suffer noise annoyance to both indoor and outdoor. In this sense, not only noise from outside is annoying, also neighbor noises, such as voices, building installations, animals and appliances cause annoyance.

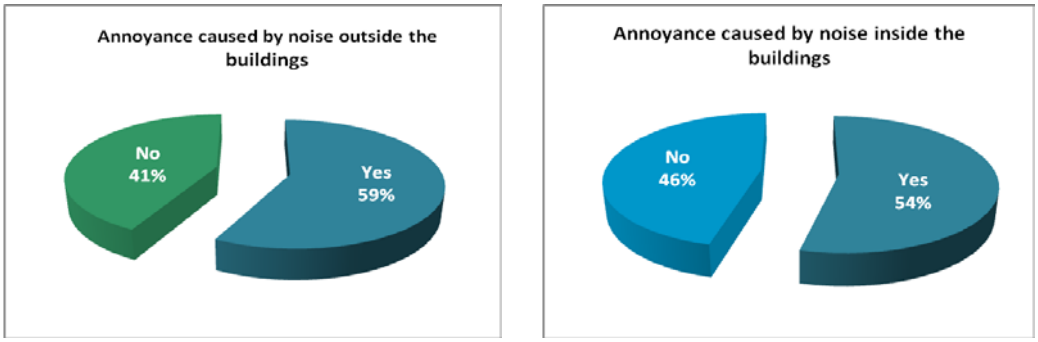

Figure 4 – Annoyance due to noise inside and outside buildings

Voices and motorcycle traffic are the exterior sources that causes more noise annoyance among people. We have to mention that there are some specific areas in the city with great activity. This areas concentrate a large number of entertainment venues as cafeterias and bars, primarily during the evening and some more specific in the night time.

Works on the street, car traffic and garbage collection are also cause high annoyance among people.

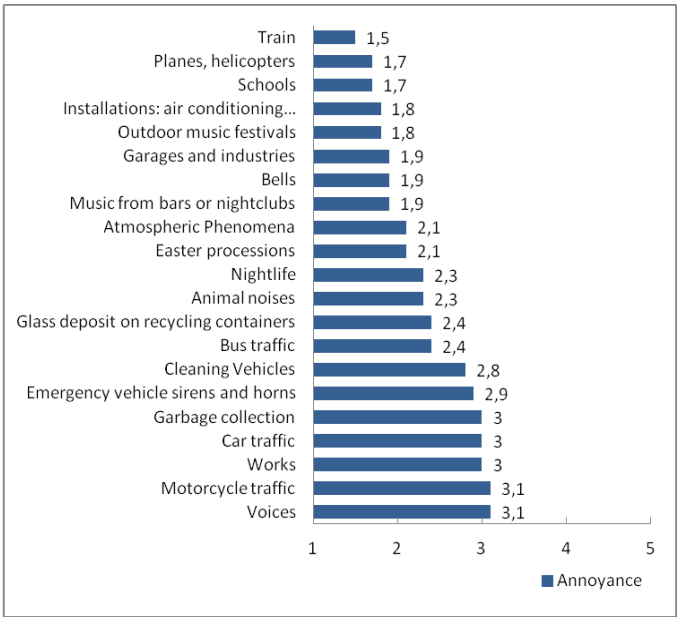

Figure 5 – Noise annoyance due to different exterior sources

2.4 Perception of the surroundings and noise

As part of the survey there where a series of questions about the perception of the surroundings and noise. In those questions, people were ask about the satisfaction regarding a number of features of their environment. The characteristic of its environment which citizens are more satisfied is water quality, with75% of highly satisfied. Adequate communication and the existence of parks and squares are also highly valued (57%). The worst valued about the characteristics of its environment are road traffic and condition of streets and sidewalks (~ 35%).

About the noise perception of their street respect to previous years, around a 68% of the people think that it is equally noisy.

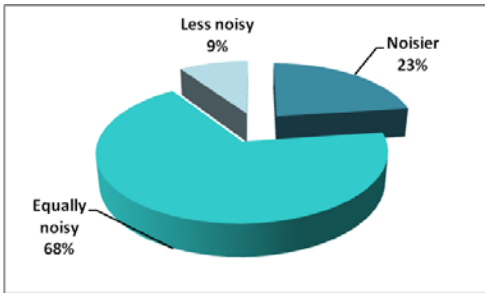

Figure 6 – Noise perception of their street respect to previous years

About the noise perception compared with the rest of the city, near half of the respondents think that the street they live is less noisy than the rest of the city. We can say that people think that the street they live has not increased noise levels respect to previous years and half of them think that their street is less noisy than the rest of them. Only 17% of them think that it is noisier than the rest.

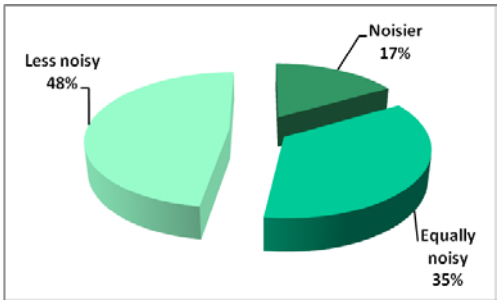

Figure 7 – Noise perception on their street respect the rest of the city

To the question about city perception in terms of sound quality, respondents are divided in 2 categories, the ones who thinks that the city is slightly noisy and the ones who think that it is noisy.

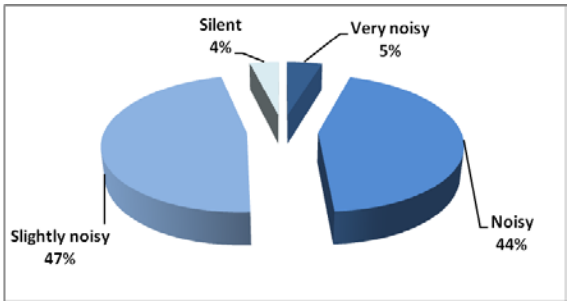

Figure 8 – City perception in terms of sound quality

There is a correlation (0,88) between noise annoyance and perception of the city in terms of sound quality related to the age of the respondents. We can say that younger people are aware of noise but it does not bother them too much. They also perceive their city as a calm city. As age advances, people

between 20 and 29 years old (most of them university students) perceived their city as less noisy than the younger ones and the annoyance due to noise is moderate. In contrast, people between 30 and 59 years old (working population) have a perception of its city as noisy and are also annoyed by noise. But there is a change after 60 years old, where as age progresses the perception and annoyance decreases, being more evident this decline in people over 80 years old, where noise is slightly annoying.

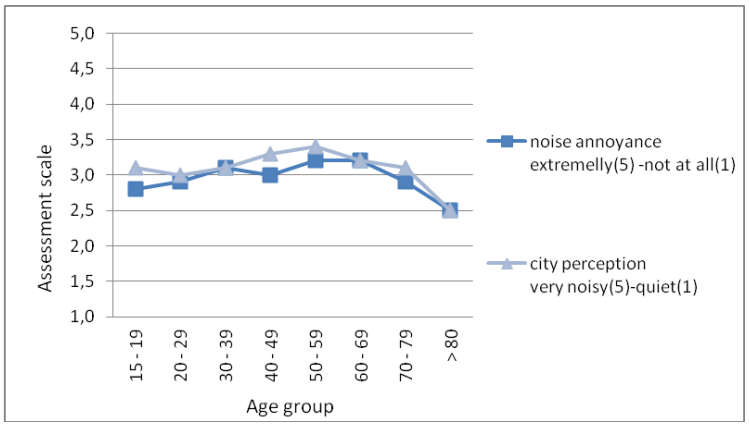

Figure 9 – Noise annoyance, city perception and age group

2.5 Relaxing sounds

70% of respondents consider that there are some relaxing sounds that help them to the development of their activities. From that percentage, 84% consider music in the first place as highly relaxing sound, followed by nature sounds (58%), fountains and birds (50%).

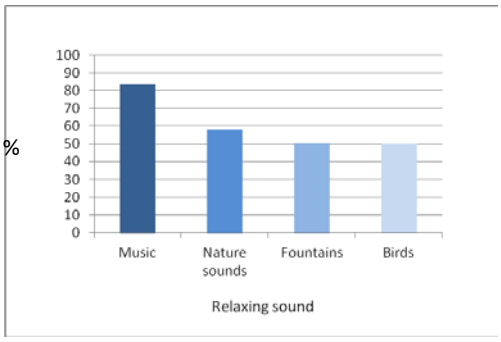

Figure 10 – Relaxing sounds

2.6 Noise effects

The biggest complaints about the effects on sleep are related to the question *Are you awoken at night by noise?*, where the 11th district is the most problematic, with 32 % of people are awakened during the night very often, followed by district number 1. As we said, 11th district concentrate a large number of bars and pubs and district 1 has lately open many pubs who can be described as after hours.

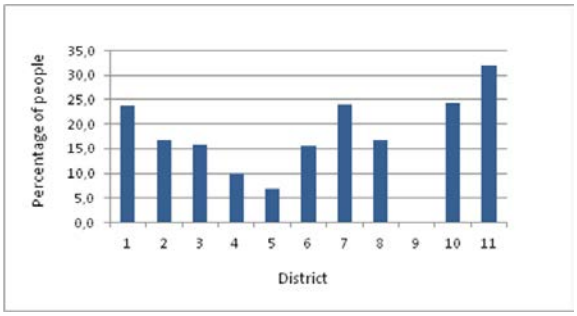

Figure 11 – Percentage of people who wake up very often during the night due to noise

Also, 32% of the respondents think about noise as extremely pollutant, while almost half of the respondents (48%) thinks that it is very pollutant.

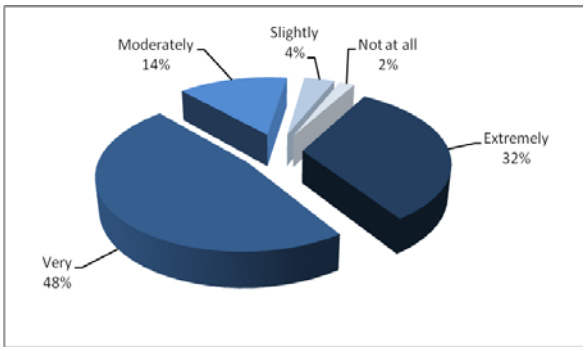

Figure 12 – Noise as pollutant

But if we measure this question in relation with the different age groups, the younger and older people thinks that noise is pollutant but moderately, while people between 20 and 69 years old, considers noise as very pollutant.

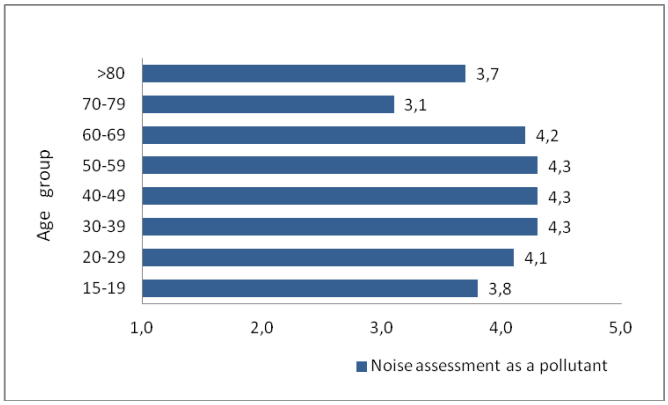

Figure 13 – Relation between age group and noise assessment as a pollutant

In relation to noise and health, 76% of the respondents over 70 years old think that noise has not affect their health, while in the rest of the population this percentage is reduced to 60,8%.

3. CONCLUSIONS

This survey has showed that exceed the maximum levels marked in the European directive does not mean that these people perceive those levels as annoying. In district number 2, 18,4% of people is annoyed by noise, while 82,7% of its population is expose to noise levels over 55 dBA during the night. We found the opposite in 11th district, where 38,5% of people is annoyed by noise, while only 25,1% of them are expose to noise levels over 55 dBA at night. We have to mention the relation between the percentage of population exposed above the exposure limit values and the percentage of people highly annoyed by noise in the street are related in the day period, around a 30%.

Almost half of the people is annoyed by noise from outside and inside of the buildings. This confirms that not only noise due to exterior sources is annoying, also neighbor noise so is the noise from neighbors. About exterior sources, voices and motorcycle traffic causes more annoyance among people.

In relation to age and noise annoyance, we have to mention that the age group between 30 and 59 years old (working population), is the most annoyed and perceived their city as noisy. Note that for the elderly (above 60 years old), the discomfort decreases and their city is perceived as less noisy. The same applies, to a lesser extent, for young people.

We have to mention that 70 % of people think that there are some relaxing sounds that facilitate the

development of their activities, like music, nature sounds, fountains and birds. This can help us to improve the quality of our cities and reduce the annoyance.

The assessment of noise as pollutant is different depending on the age of respondents. Over 80% of them consider noise as highly pollutant, but in the group of people over 70 years old, 15.8% believe that noise is not at all contaminant, while 13.2% consider it as less pollutant.

The biggest complaints about the effects on sleep are related to sleep disruption, where the 11th district is the most affected, followed by the 1st district. The 11th district is a pedestrian area with numerous noise sources, especially the ones due to nightlife. Likewise, 1st. district has a small pedestrian area where lately have been placing pubs and night clubs.

Finally we have to mention that around 60% of the people think that noise has not affect their health. This percentage increases among people over 70 years old (76%).

ACKNOWLEDGEMENTS

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