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A Social Survey on the Effects of Environmental Noise on the Residents of Pamplona, Spain

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ABSTRACT

An extensive noise survey carried out in the city of Pamplona, Spain over 2 years has allowed us to elaborate a detailed daytime acoustic map of this city. The degree of noise annoyance in the community and its relationship with the measured noise levels has also been studied by means of a social survey. © *1997 Elsevier Science Ltd*

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INTRODUCTION

Pamplona is a medium size city (around 200 000 inhabitants) located in the north of Spain. The old part of the city has very narrow streets, all of them open to road traffic. Over the centuries, the city has expanded outwards through a number of successive urban developments. The important industrial growth experienced mainly in the decades of 1960s/1970s produced a significative deterioration of the environmental conditions of the city. Although the recent opening of a peripheral highway (avoiding heavy vehicles crossing the city centre) has alleviated considerably the previous situation, the noise levels measured in many residential areas of the city during the 24 hours of the day are very high.

An extensive noise survey has been carried out recently in this city in order to study the magnitude and characteristics of this environmental problem. This work presents the results obtained in the evaluation of the response and attitudes of the residents of some specific residential areas of the city to the

environmental noise and studies the relationship between noise annoyance and the measured noise levels.

SPECIFIC NOISE LEVEL MEASUREMENTS

A-weighted noise levels in these areas were continuously measured over 24 h periods, both on working and non-working days, in five different residential areas of the city (Chantrea, San Juan, San Jorge, Ensanche and Casco Viejo). The selected locations are representative of different urbanistic and environmental situations to be found in the city. All measurements were carried out using a 1/2 inch (12.5 mm) condenser microphone (Brüel&Kjaer, type 4165), a noise level analyzer (B&K, 4426) and an alphanumeric printer (B&K, 2312). In all cases, the instantaneous sound levels were sampled every 0.1 s, resulting in a total of 36 000 samples per hour. All hourly values of L1, L10, L50, L90, L99 and L_{eq} were obtained over complete 24 h periods. The microphone was always mounted in the most exposed facade (balcony) of a dwelling in the zone.

Figures 1 and 2 show some examples of the results found for the L_{eq}, L10 and L90 sound levels measured in two different urban areas. In general, the time variation of the diurnal noise levels (from 8.00 to 21.00 hours) is insignificant. As expected, the noise level values are strongly dependent on the specific characteristics of each location. For instance, the values of equivalent sound levels range from about 75 dBA measured at 12.00 hours on a working day in a quite busy road (San Jorge area), to 60 dBA measured at

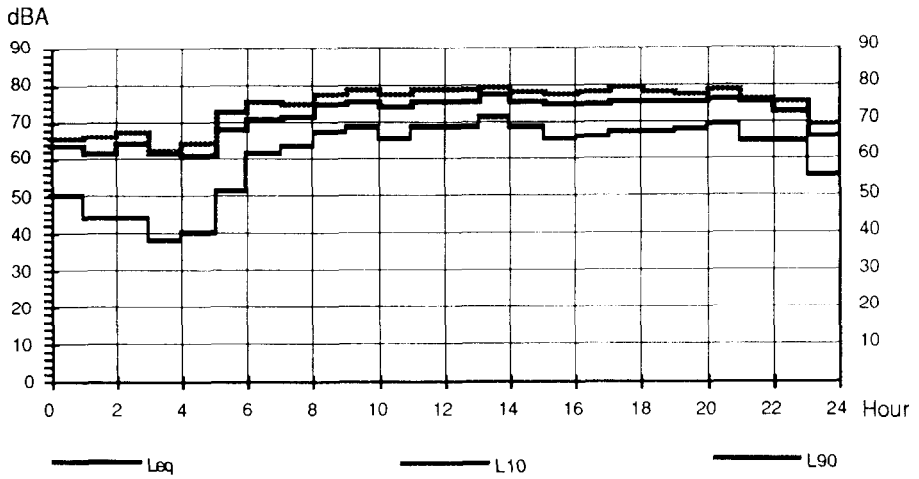

Fig. 1. Variation in some community noise descriptors (L10, L90 and L_{eq}) over the 24 h of a working day in a busy residential area of the city of Pamplona.

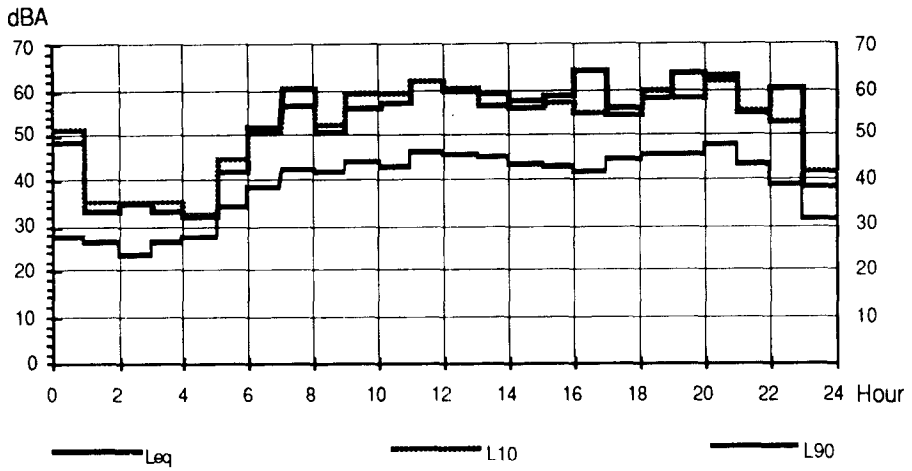

Fig. 2. Variation in some community noise descriptors (L10, L90 and L_{eq}) over the 24 h of a working day in a quiet residential area of the city of Pamplona.

the same hour in a relatively quiet location (Chantrea area). It has also been observed that in some districts the noise levels measured on working days and Sundays exhibit important differences, again depending on their specific characteristics.

SOCIAL SURVEY

The subjective response to noise exposure was measured by means of a social survey. This survey was carried out in each one of the five residential selected areas, and it was performed in order to investigate the individual's attitude and opinion to different aspects of the environmental noise problem in the city. The investigation was carried out by using the traditional techniques generally applied in studies of this kind. The questionnaire contained the usual questions on demographic data, residential environment and noise nuisance. To avoid any possibility of bias, the survey was not introduced to the interviewed people as a noise survey, but as an enquiry related to general environmental conditions and community services.

The people to be interviewed resided in flats very close to the location where the noise level measurements were carried out. Consequently, it can be assumed that all of them are exposed to the same noise levels as measured in the noise survey. A letter was sent to one selected person per dwelling by the local Councillor for Environment and Health announcing the survey and asking for cooperation. A few days later, a municipal officer delivered personally the questionnaires. A total of 600 questionnaires were distributed.

The same officer returned later to collect the completed questionnaires. A total of 496 questionnaires were finally collected (102 in Chantrea, 81 in San Juan, 84 in San Jorge, 62 in Ensanche and 167 in Casco Viejo). The above mentioned procedure was doubtless a most important factor in the success of the present social survey.

RESULTS

The respondents were male (59%) and female (41%). The ages of interviewed people exhibit a wide age range: 20–30 years (13%), 30–40 years (22%), 40–50 years (15%), 50–60 years (19%) and older than 60 years (26%).

The satisfaction level of the interviewed people regarding their neighbourhood has been carefully considered in this investigation. In general, the evaluation of most of the services (schools, shops, public transport, etc.) and the environmental conditions (air pollution, noise, etc.) is quite positive: about 62% of the respondents declared to be satisfied with the city zone where they live. However, it has been observed that the satisfaction level in the quietest areas (Chantrea, San Juan and Ensanche) is higher than in the noisiest areas (Casco Viejo and San Jorge).

In general, environmental noise is considered to be an important factor in the quality of life in Pamplona. Although the problem is most serious in the residential zones exposed to high sound levels, the responses as to whether noise is a problem are largely affirmative in all cases (about 85% of the respondents). The differences observed in this sense between males (89%) and females (83%) are not significant ($p < 0.01$). The noise produced by road traffic is considered the most negative environmental factor in San Jorge area (it should be noticed that this district is crossed by a main road, with a mean traffic volume over 38 000 vehicles per day). However, in Casco Viejo and San Juan areas, the most negative factor is the noise produced by the bars, pubs and discoteques (both zones are characterised by a high concentration of these leisure establishments and an intense "night life", especially during the weekends).

The question regarding the type of vehicles that produce most noise annoyance is answered as "motorcycles" by the respondents in all zones, with the exception of people living in San Jorge, where the most annoying vehicles are "heavy vehicles". It is interesting to stress that motorcycles are the most bothersome vehicles for all age groups, including people under 20 years old. These results coincide with those found in similar surveys carried out by other authors in different cities.[1,2]

Attitudes to road traffic noise were elicited by means of a five step semantic scale. About 31% of the interviewed people declared to be "very much

annoyed", 23% "rather annoyed", 21% "moderately annoyed", 15% "little annoyed" and 10% "not annoyed at all". Table 1 summarizes the results obtained in each different location. As expected, the responses to this question vary considerably in each case, according to the specific conditions. For instance, about 77% of the respondents in San Jorge declare themselves "very much annoyed" by the road traffic noise, compared with 10% of the respondents in Chantrea.

One of the most negative effects of the environmental noise in urban zones is probably sleep interference. Exposure to noise can induce disturbances of sleep in terms of difficulty to fall asleep, alterations of sleep pattern or depth and awakenings; these effects are referred to as primary sleep disturbance effects. Other primary physiological effects that can be induced by noise during sleep are increased blood pressure, increased heart rate, change in respiration, body movements, etc. Exposure to nightime noise can also induce secondary effects (that is, effects that can be measured in the day after the noise exposure), including reduced perceived sleep quality, increased fatigue and decreased performance.[3,4] In this sense, it has been found in the present study that the responses to the question "Are you awoken at night on account of the noise?" differ considerably from one location to another. Table 2 shows the results obtained in each case. About 42% of the respondents of San Jorge reported waking "often" in the night, compared with 7% of the respondents of Chantrea.

TABLE 1

Responses Given by the Residents in Five Different Residential Areas of the City of Pamplona to the Question "In what measure does road traffic noise annoy you?"

	San Jorge	*San Juan*	*C. Viejo*	*Ensanche*	*Chantrea*
Very much (%)	79	26	26	20	10
Rather (%)	17	34	28	27	10
Moderately (%)	4	22	25	30	23
Little (%)	0	10	14	12	35
Not at all (%)	0	8	7	11	22

TABLE 2

Responses Given by the Residents in Five Different Residential Areas of the City of Pamplona to the Question "Are you awoken at night by the noise?"

	San Jorge	*San Juan*	*C. Viejo*	*Ensanche*	*Chantrea*
Very often and often (%)	43	42	41	13	7
Sometimes (%)	32	33	23	18	15
Few times and never	24	25	36	69	78

Closing the windows even though the temperature may be high (summer) is the strategy usually employed to reduce intruding noise. In general, the responses in that sense follow the same trends illustrated in Table 2. Thus 75, 52, 46, 32 and 24% of the interviewed people in San Jorge, San Juan, Casco Viejo, Ensanche and Chantrea, respectively, declare that they sleep with the windows closed in summer.

A huge percentage of the interviewed people (about 91%) think that environmental noise is a very important factor in the quality of life in cities. However, personal response to environmental noise is scarce: about 86% of the respondents to our questionnaire have never actually complained about noise. The number of people complaining is very low in Ensanche and Chantrea, where the main noise source is road traffic, generally considered as unavoidable and anonymous. On the other hand, the complaints are relatively higher in San Juan and Casco Viejo, where the most annoying noise sources (restaurants, pubs and people's voices) are much more easily identified by the residents.

The nature and physical characteristics of the most important noise sources can be objectively assessed and evaluated. However, the nuisance produced in a given community depends also on a number of other factors (personal attitudes to noise problem, evaluation of the need of a vehicle or service, etc.). In general, it is very important to know what opinion the community has of the measures to be taken by the Administration to fight against environmental noise. Therefore, in the questionnaire used in the present survey, the interviewed people were requested to make some suggestions about a number of possible measures to reduce the noise levels in the city. Table 3 resumes the global responses obtained from this request. It is worthwhile indicating that, after considering the results of present investigation, the Environmental Health Service of the Local Government of Pamplona has recently taken a number of measures to control the noise produced by motorcycles and cars.

TABLE 3

Global Responses Given by the Residents in Five Different Residential Areas of the City of Pamplona to the Question "What specific measure would you propose to reduce the level of noise in the city?"

1.	To fine the motorcycles that operate without silencers	34%
2.	To control the noise caused by the vehicles andto fine them when they exceed a certain level	20%
3.	To make the closing time of bars, pubs and discos earlier	17%
4.	To limit the heavy vehicle traffic from 23.00 to 7.00 hours	8%
5.	To pedestrianise some of the streets	8%
6.	To collect the garbage before 23.00 hours	7%
7.	To forbid industries and vehicle repair workshops	3%

CORRELATION BETWEEN ANNOYANCE AND NOISE LEVELS

The environmental noise nuisance has been evaluated from the responses to two different questions in the survey. The first question is related to the general annoyance ("In what measure does road traffic noise annoy you?"). The second question is related to sleep interference ("Are you awoken at night by the noise?"). The response to these two questions were recorded on a five point semantic scale ("very much", "rather", "something", "little" and "nothing"). To find possible correlations among the different degrees of annoyance and environmental noise levels, numerical values have been assigned to the above mentioned semantic scale (5, 4, 3, 2 and 1, respectively). The homogeneity of variances was proved by means of the Barlett test, since the size of the samples were not the same in the five urban zones considered.

The correlation was calculated using five pairs of values: the nuisance indices (calculated as the weighted response to the above questions in the five zones) and the most usual global noise descriptors (calculated from the noise level values measured in the five zones). A number of different noise indices were considered. The main data and results of this analysis are summarized in Table 4. It should be observed that the best correlation between general noise annoyance (first question) and sleep interference (second question) corresponds to the night–day equivalent sound level L_{dn} measured on working days. In general, global noise indices measured in working days correlate better than global noise indices measured on non-working days.

Figure 3 offers equivalent information on the results obtained in this study. In this case, the percentage of people highly annoyed by noise is represented versus the values of day-night equivalent sound level Ldn measured in each of the five different city zones. The data obtained in the present work are integrated in the well known graph prepared some years ago by Schultz, summarizing the information found from different social surveys.[5]

TABLE 4

Some Results of Noise Level Global Descriptors (in dBA) and Nuisance Indices, where R_1 and R_2 are the Weighted Response to the Questions "In what measure does road traffic noise annoy you?" and "Are you awoken at night by the noise?", Respectively

	L_{eq} 24 h		L_{dn}		R_1	R_2
District	*(working days)*	*(non-working days)*	*(working days)*	*(non-working days)*	*(scale: 1–5)*	*(scale: 1–5)*
Chantrea	58.4	58.1	62.1	63.0	2.52	1.81
San Jorge	73.3	69.2	76.4	74.2	4.76	3.31
San Juan	64.2	65.7	68.7	73.2	3.60	3.27
Ensanche	67.6	66.8	69.4	73.1	3.32	1.95
Casco Viejo	69.6	70.7	73.9	79.1	3.52	3.09

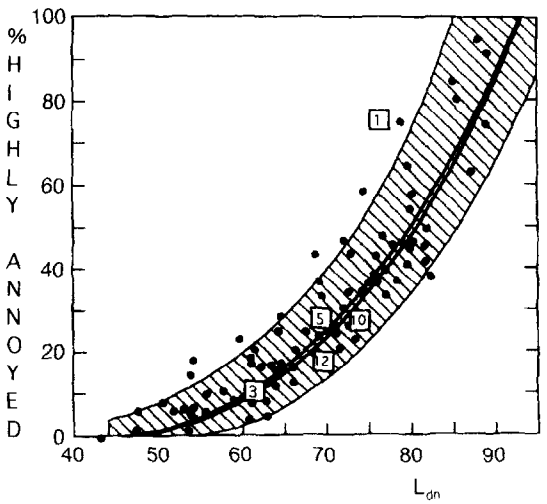

Fig. 3. Percentage of "highly annoyed" people (%) related to the value of day–night equivalent sound level L_{dn} (dBA). The data represent the results found in the present survey in five different residential areas of the city of Pamplona (districts: 1. San Jorge; 3. Chantrea: 5. San Juan; 10. Casco Viejo; 12. Ensanche), together with those obtained in other studies carried out in different countries.[5]

CONCLUSIONS

The results obtained in the present survey conclude that environmental noise is an important problem in Pamplona. The diurnal equivalent sound levels measured in 185 different locations evenly distributed around the city exceeded 65 dBA in 59% of the locations. The social survey carried out in five representative areas of the city has shown that noise annoyance is a serious problem for many residents. In particular, it has been found that the percentage of people suffering from sleep disturbance is clearly unacceptable in three of the five districts included in the survey. Obviously, a number of administrative and technical measures are needed to improve the present situation.

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