FIFTH INTERNATIONAL CONGRESS ON SOUND AND VIBRATION
DECEMBER 15-18, 1997
ADELAIDE, SOUTH AUSTRALIA

EFFECTS OF TRAFFIC NOISE WITHIN THE MADRID REGION

Recuero M., Gil C., Grundman J.

Instituto Universitario de Investigación del Automóvil. ETSI Industriales.
Universidad Politécnica de Madrid.
Km 7 Carretera de Valencia
Madrid 28031 Spain
Phone: (34) 1 336 53 10 Fax: (34) 1 336 53 02
E-mail: mrecuero@diac.upm.es

ABSTRACT

In this work the results of a 20-question survey about the acoustic environment made on the population of 17 towns are presented. Up to 7143 questionnaires were distributed, where 3274 were conducted in population centers with more than 100000 inhabitants, 2695 in towns below 100000 and above 50000 inhabitants and 1174 in towns with less than 50000 inhabitants.

1. INTRODUCTION

A 20-question survey has been conducted on the population in 17 towns in the Madrid region in order to know their opinions about different aspects of their sound environment.

Those aspects include questions about noise in the municipalities and how annoying it is considered, areas and time of the day distribution and long term evolution. There were questions related to acoustic conditions in dwellings, especially its noise isolation, but also about the effects of environmental noise on those polled. Finally, citizens were asked how important they think environmental noise problems are; how deep is their knowledge of their rights and existing law and what measures should be taken to improve the situation.

Cities were divided into three groups according to their size: 1) below 50,000 inhabitants, 2) more than 50,000 but less than 100,000 and 3) above 100,000 inhabitants. The survey was done on 7,143 residents, of which 1174 belonged to the first group, 2695 to the second and 3274 to the third.

Polled subjects were 45 % male and 55 % female, with 45 % between 21 and 40 years old. 17 % had a university degree, while 37 % were undergraduate level and 31 % had just a primary background.

2. SURVEY

This work is a part of a broader project that involves a noise map of all 17 towns under study; the questionnaires were therefore issued in each town simultaneously with noise level measurements. Comparison between survey data and measurements give therefore more reliable overall results.

In order to get a minimum number of subjects in the sample that can still ensure representative results, a statistical equation has been used. It is known that the extension of the sample beyond certain point does not render much better precision. The following expressions are used in order to assess the optimum value of n, the sample size:

$$n = (Z(X/2))^2 \cdot \frac{p \cdot q}{e^2}$$

$$n = \frac{N \cdot (Z(X/2))^{2} \cdot p \cdot q}{e^2 \cdot (N-1) + (Z(X/2))^2 \cdot p \cdot q}$$

Our study deals only with population proportions: p and q ($q = 1 - p$) represent the true value of the population proportion estimated, or some approximation. When this is unknown, it is usually taken as $p = q = 0.5$, which gives a maximum of the product $p \cdot q = 0.25$ and a conservative value for n. The second formula includes N, the size of the population, and it is applied when the sample is above 5 % of the population. The first and shorter expression is generally valid for relatively big populations. $Z(X/2)$ represents normal distribution.

If we set the desired values of error e and corresponding confidence level ($[1 - X] \cdot 100$), n is obtained. The confidence level was 95 % in all cases, giving $Z(X/2) = 1.96$.

The questionnaires were left at the chosen homes and several days were allowed for family members to answer before collecting them. To obtain an unbiased sample, similar proportions of sexes and representative age composition were selected.

The information in the questionnaires was transferred to a database program to facilitate review and processing. A software application developed from MS Access 97 was used to obtain the results for every city and overall. These results were then copied into a spreadsheet in order to plot them in graphics.

Figures 1, 2 and 3 contain information about the subjects polled: age, sex and background. The population sample can be considered young, with more women than men and a relatively small amount of higher education subjects.

Figure 1
Age classification

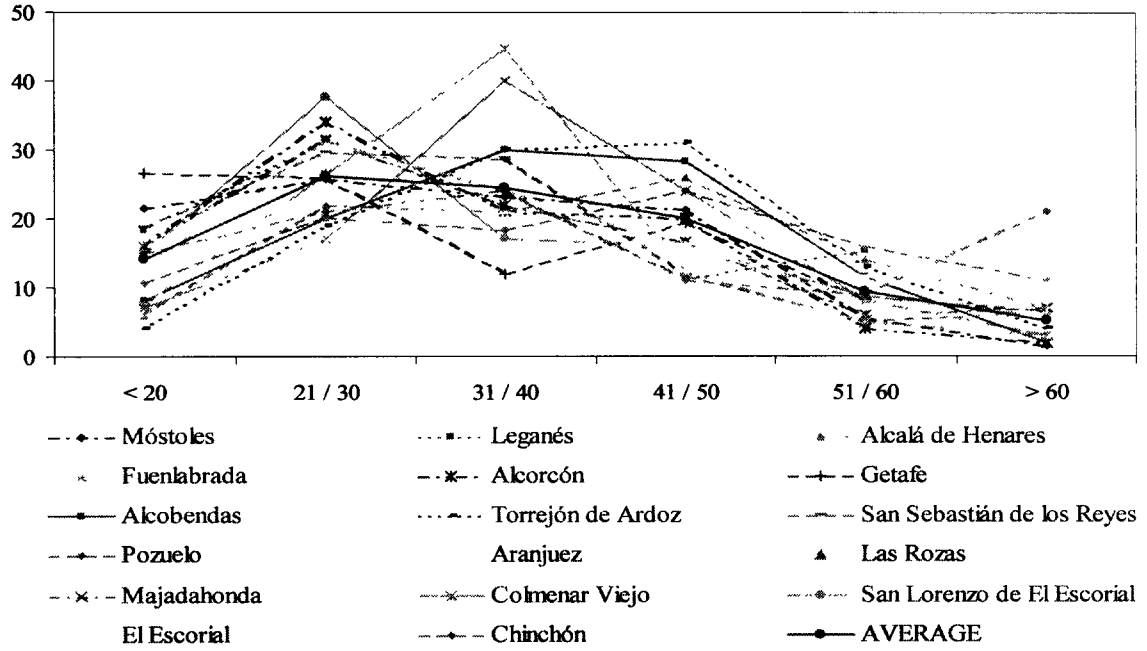


Figure 2
Background level

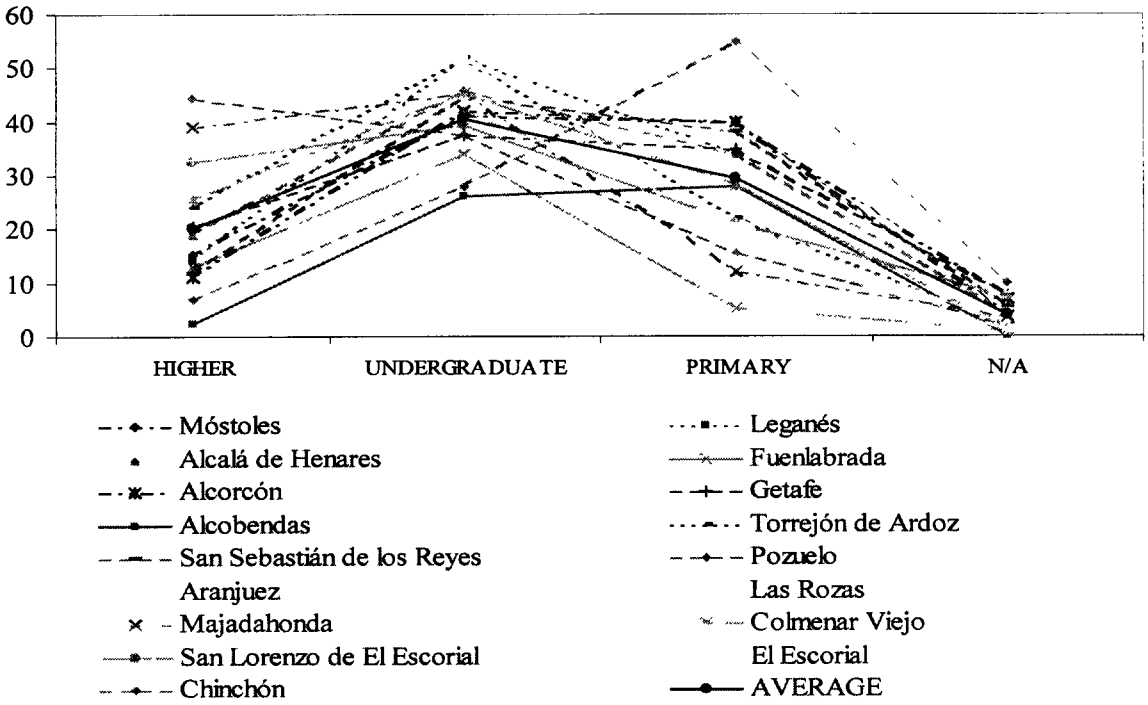
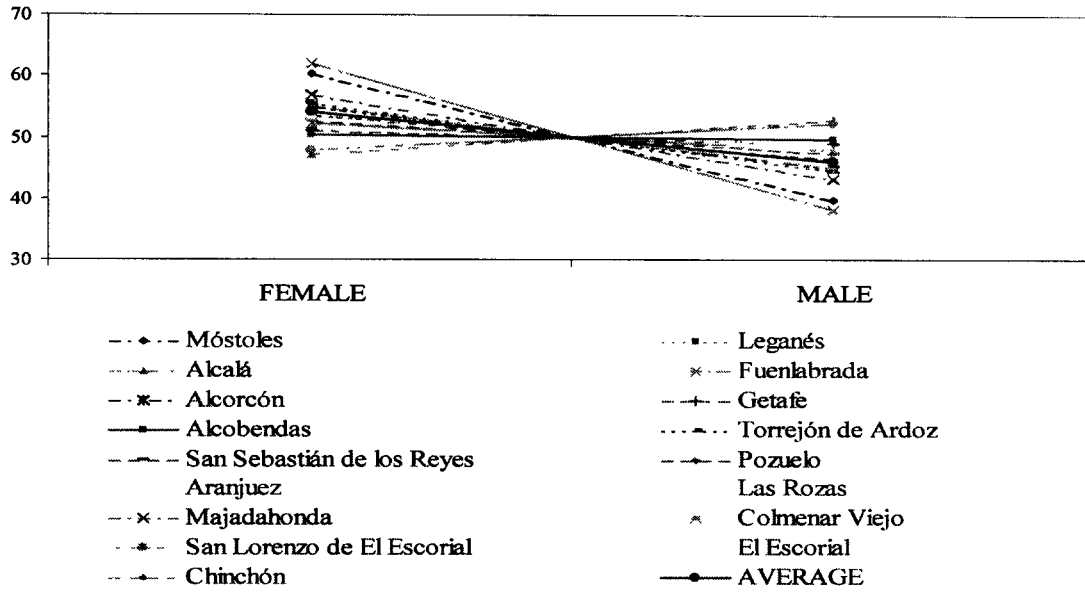


Figure 3
Sex proportion

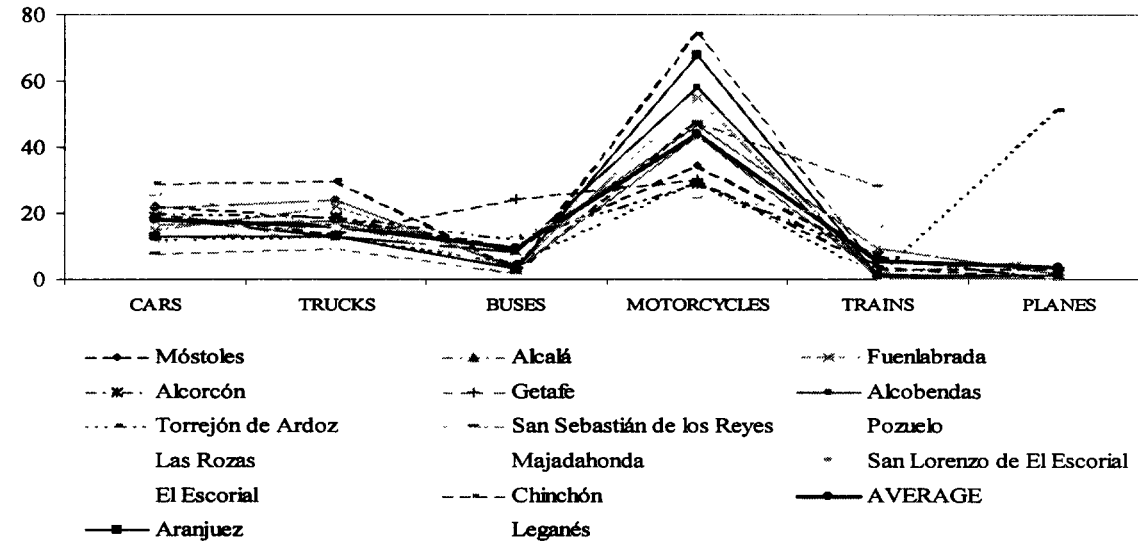


3. RESULTS OBTAINED

Traffic noise is the most generalized annoyance reported (32 %), followed by community noise (22 %) and building work (11 %). It could be noted that, apart from the above mentioned annoying activities, there are others, like leisure places, workshops and shopping areas which do not bother most polled subjects.

Noise in the workplace is considered not important by 43 %, moderately annoying by 33 % and very annoying by 18 %. It may seem a good result, but even this should not be admitted if we want to establish adequate working conditions.

Figure 4
Annoyance of different kinds of vehicles



Motorcycles are pointed as the noisiest vehicles (see figure 4). This could be explained by a high concern about their usually high noise levels.

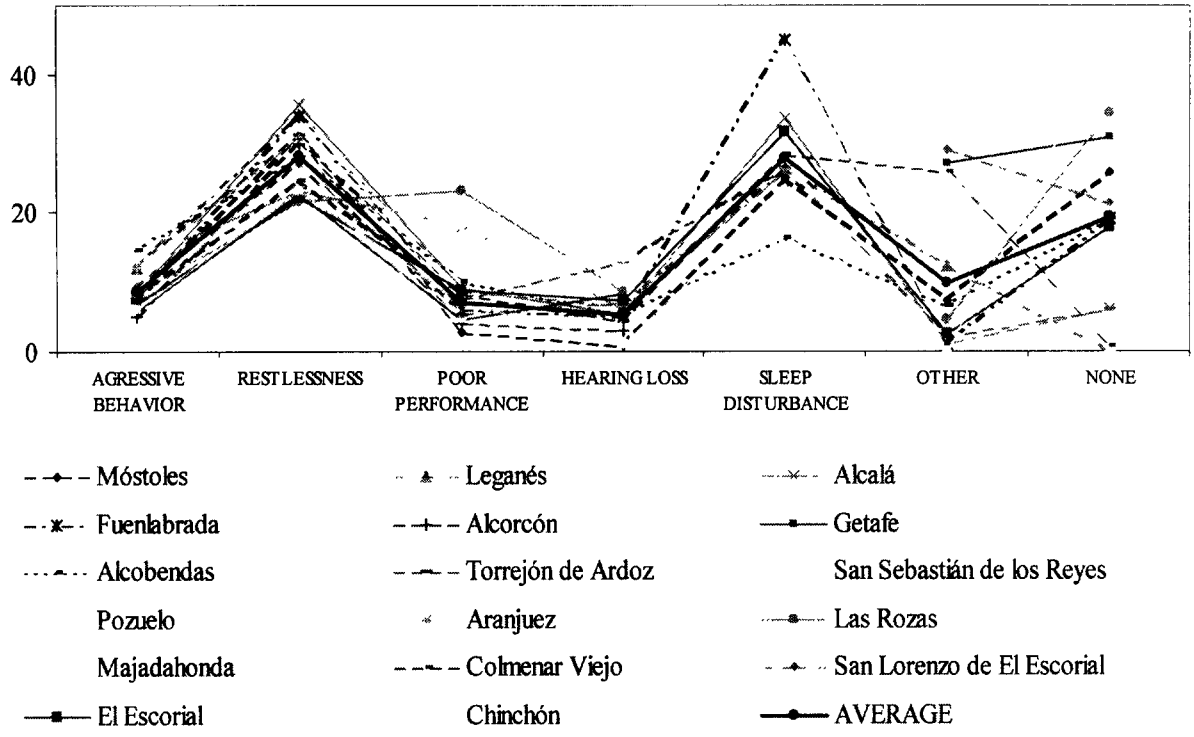
Private cars and buses are the most popular transportation methods either within towns or between them. Train (14 %) and walking (10 %) follow, but taxis and bicycles are scarcely used.

56 % think noise environment did not change during recent years and only 11 % report a big increase.

Summer is the season when noise is more annoying (76 %); this seems logical if we consider windows are left open in during this part of the year. As to daily periods, night is said to be noisiest by 43 %, while 34 % think it is worse during daytime and 23 % say it is the same. Most people (61 %) think acoustic isolation is not good enough in their houses.

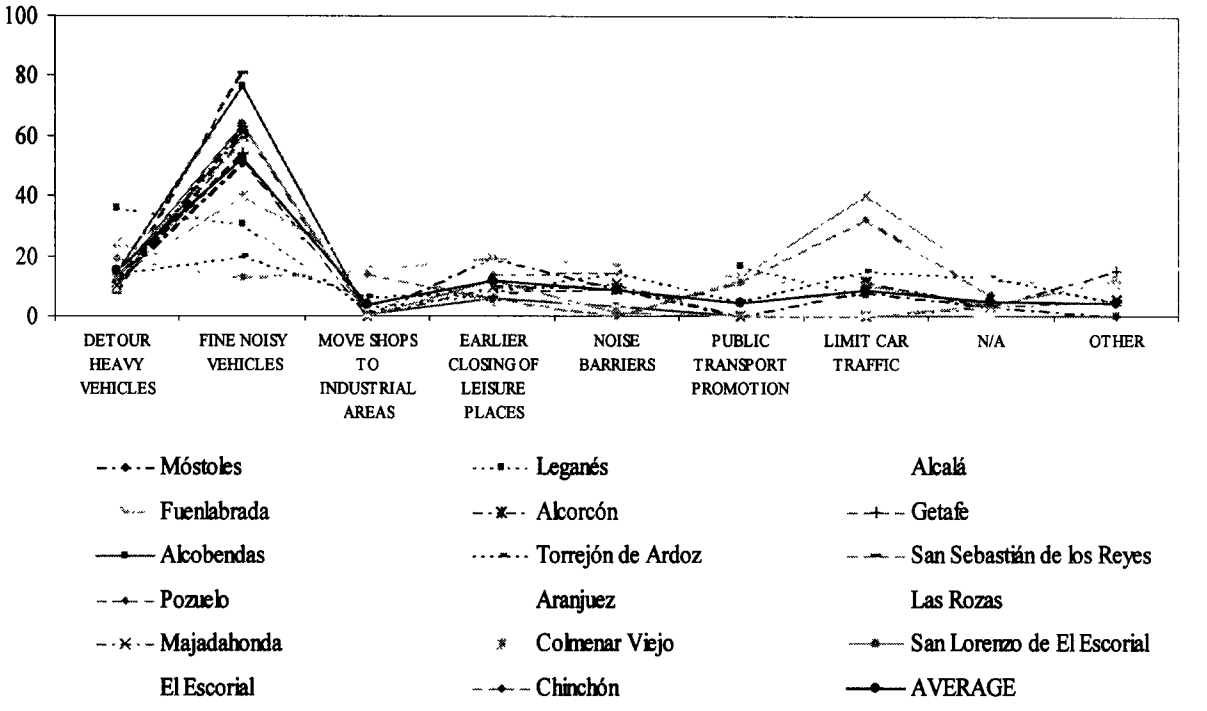
The mentioned result about noise during nighttime explains the complaints about nervousness (26 %) and sleep disturbance (17 %) as the most important effects on health (figure 5).

Figure 5
Effects of noise on health



There is a big concern about noise in the community: 81 % consider this environmental problem affects their quality of life. The response to proposed measures to solve or reduce noise pollution gave this result: fines to noisy vehicles (44 %), limit traffic of heavy vehicles (14 %), and similar results to other proposals, as shown in figure 6.

Figure 6
Noise reduction measures



Most of the polled subjects think authorities are not correctly fighting noise (75 %) and law should be stricter in this matter (77 %). Nevertheless, 56 % declare they do not know which legal measures must be taken in noise complaints; only 43 % claim they do. This fact indicates there are no easy and direct ways to obtain this information.

4. CONCLUSIONS

Results are commented in this section, comparing those from each municipality between them and with the overall result in the Madrid region. Possible explanations to the differences are given.

Traffic is reported as the most annoying noise source in towns above 100,000 inhabitants (33-38 %). There is one case in this group where leisure activity disturbance is much smaller; this is due to the fact that leisure places have been moved to an industrial area outside the city, where there are no inhabitants to be disturbed.

Middle-sized municipalities (50,000-100,000), show similar annoyance levels for traffic and community noise, followed to a lesser amount by street and building work.

Smaller towns (below 50,000) have more diverse results, but in general they have a quieter environment and small or no annoyance.

Noise in the workplace is more often complained about in bigger cities (20-23 %) than small ones (12-16 %).

As to the most annoying kind of vehicles, motorcycles are pointed out more often than the others: 41.8 % in average and as much as 63 % in one place. In Getafe, one of the region's

big cities, buses are more annoying and almost equal motorcycles in the survey. In Torrejón de Ardoz, which is next to an airport, planes are the most annoying noise source.

Big municipalities are more annoyed by cars and trucks, followed by motorcycles. In middle-sized cities motorcycles increase its disturbance over cars and trucks. Finally, small towns report an overwhelming disturbance from motorcycles, even 74 % in one case.

Private cars are in general the most common transportation method, but bigger cities show a tendency towards using trains more often than cars, if compared with the average result. Small towns have less public transportation, and therefore cars, or even walking, are more popular.

Most Madrid region inhabitants polled (62 %) have not experienced noticeable increase in noise levels in or around their houses since they first occupied them, while 37 % think there was such increase. This last percentage raises to 53.5 % in bigger cities, but smaller cities have up to 87.3 % of no change in noise conditions reported.

People are not generally satisfied with existent acoustic isolation in their houses (60 %); some big municipality has even 81.5 % of unsatisfied. Middle-sized towns have an average 36 % satisfied citizens (46 % in one case), while small town's inhabitants are mostly satisfied (44.7-67 %) with their acoustic isolation. From this data it can be said that people in smaller towns is usually happier with acoustic conditions in their houses.

All municipalities agree to mention summer as the noisiest season (73 % in the whole region): big ones vary from 70 to 78 %, while middle and small-sized have a bigger proportion who thinks no season is noisier than other (above the 17 % average, and up to 33-39 %).

There is a small difference between those who say nighttime is noisier (39 %) and those who think it is during daytime (31 %). There is only one town with a different pattern (40 % daytime, 27 % nighttime), due to airport traffic.

As to the effects of noise on those polled, only Fuenlabrada have more people complaining about sleep disturbance (45 %) than they do about restlessness. There is a quite high percentage that loses performance at work in middle-sized cities (18-23 %). Small municipalities have a weaker incidence of restlessness, but sleep disturbance does not appreciably change.

Most people polled is aware of the consequences of living in a noisy environment (80 %); 78-86 % in bigger cities, 64-91 % (more variation) in middle-sized cities, and less in small towns (67-74 %). The results seem logical if we consider that bigger cities are noisier, and therefore more conscious of the problem.

Big and middle-sized cities show more disapproval towards authorities' actions against noise than small towns. When people is asked if noise is being fought properly, most answers are negative, but there is a high percentage of no answer (21-27 %).

Big municipalities have a preference towards stricter legislation against noisy activities (78 %), but some places like Fuenlabrada had a good proportion (32 %) that did not answer this question. Small municipalities have larger percentages of citizens thinking a change in law is not necessary (51-76 %).

When asked if they know what legal actions can be taken in order to solve a noise problem, small-town citizens are more ignorant in this respect (77 %).

A majority (53 %) proposes fining noisy vehicles as a good measure to fight the problem. More measures were proposed in bigger cities, where noise level is higher. In one case, a traffic detour is proposed as the first choice (37.5 %, when the total average is only 14.7 %). In Alcalá de Henares, fining is by far the most popular measure (70 %), while other

possible actions are also proposed: heavy vehicle detouring (25 %), acoustic barriers (25 %) and earlier closing of bars and discotheques (19 %), all of them above the region's averages.

Middle-sized municipalities also prefer fining (only Torrejón de Ardoz, with 20 %, is well below the average, 52 %, in this matter). Other measures give smaller results, close to total averages: heavy vehicle detouring (14 %), acoustic barriers (9 %) and earlier closing of bars and discotheques (12 %).

Finally, small municipalities have similar proposals against noise, in the same proportions except for the case of fines for noisy vehicles, which is lower (52.3-63.8 %) and moving stores and workshops to industrial areas, which is higher (14-17 %).