Nuisance caused by aircraft noise in the vicinity of Tehran International Airport

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Abstract
Noise measurement and social questionnaire surveys in three residential areas around Mehrabad International Airport (Tehran, Iran) were based upon randomly selected dwellings in each area. A total of 193 individuals responded and many are annoyed and dissatisfied with aircraft noise and in consequence they would like to move. Aircraft noise is the strongest negative environmental factor affecting the residents in the vicinity of Mehrabad Airport and it could be a hazard for their health.

Introduction
Annoyance is a common psychological response to noise (Mclean and Tarнопольский, 1977; Tarнопольский et al., 1980) defined as: feeling bothered by noise disturbance or displeasure associated with any agent or condition, conversation and rest interference (WHO, 1980); fatigue or headache (Stansfeld et al., 1985). Daily exposure to environmental stressors can create annoyance and decreases the quality of life for those who view it as unnecessary and uncontrollable (Cohen et al., 1986). Disturbance of sleep by noise is often the underlying reason for noise annoyance (Stream, 1980). Speech interference by noise is also annoying (Mulholland and Attenborough, 1981), and communication interference causes widespread annoyance (Loeb, 1986; Smith, 1991). Residents around two airports in Canada, Toronto (International) and Oshawa (Municipal) (Taylor et al., 1981) showed the percentage of people highly annoyed was considerable for both airports. In France, the Netherlands and the UK, 80 per cent of people were annoyed at 55 NNI (Vallet et al., 1988).

Interference with activities might be a source of greater annoyance where in successful achievement of the activity is highly valued by the subjects (Levy-Leboyer and Moser, 1987). Annoyance is associated with the noise level and type of activity. The context is also important (Cheifetz and Borsky, 1980) and annoyance is a direct effect of noise on conversation, mental concentration, rest or recreation (WHO, 1980). The relationship between aircraft noise (Gunn et al., 1981; Moran et al., 1981; Vallet et al., 1988; Smith and Stansfeld, 1986), train noise (Ahlrin and Rylander, 1979; Clegg, 1979), traffic noise (Karami and Frost, 1995; Langdon, 1976; Rylander et al., 1976), industrial noise (Ohrstrom and Bjorkman, 1978; Melamed et al., 1988) and power lines noise (Lehrman, 1981) established a positive correlation between noise and annoyance. A greater percentage of people were highly annoyed by aircraft noise as compared to road traffic noise at the same noise level (Hall et al., 1981; Rohrmann, 1978). Higher annoyance levels were found for road traffic than for trains and tramways when compared to aircraft noise (Ahlrin and Rylander, 1979). In Hamburg (Germany) people are more annoyed by aircraft noise than other sources of urban noise. Respondents believed that aircraft noise was the most unpleasant type of environmental noise, even if they did not live near an airport. The further rank order was street traffic, factories, construction and railways (Rohrmann, 1978). In the UK there have been few complaints about railway noise, yet sound levels generated along railways are higher than levels from various other sources which frequently give rise to widespread complaints (Clegg, 1979). A social survey (Fidel and Silvati, 1993) on the prevalence of annoyance in Hartfield International Airport (ATL) in Atlanta shows that aircraft noise was the most disliked aspect of neighbourhood life for residents of both acoustically treated and untreated homes in all noise exposure intervals.

Annoyance with aircraft noise has often been associated with fear and the belief that the noise could be prevented if adequate measures were taken (Field and Walker, 1982). Respondents living directly underneath a flight path are more annoyed than people living outside the path (Gjestland, 1988). The fear of crashes in the neighbourhood are an important factor for generating annoyance with aircraft noise (Gunn, 1987; Gunn et al., 1981; Reijneveld, 1994).

Materials and methods
The questionnaire was based on earlier investigations (Diamond and Rice, 1987; Jue et al., 1984; Mclean and Tarнопольский, 1977; Tarнопольский and Morton-Williams, 1980) with standard commonly used questions. The
A questionnaire was designed in a form that made it easy for residents to answer the questions. Social surveys to measure human reactions (Hade and Bullen, 1982) require respondents to give a rating of their feelings in relation to particular annoyance factors. Questions should therefore include the word and directly relate to “annoyance”. This recommendation was adopted for the questionnaire used in the Tehran survey. Residents were encouraged to include individual perceptions on health, communication and satisfaction in relation to aircraft noise and to rate their feelings using the descriptive phrases “very much”, “fairly”, “a little”, “very often”, “quite often” and “rarely”. Two sound level meters were calibrated and standardised by the Department of Applied Acoustics, University of Salford. Noise measurements and social surveys were carried out at three sites in the airport residential area. Measurements were made when the effects of environmental vibration, humidity, wind, temperature and rain were insignificant (Jamab Consulting Engineers, 1991) on sunny and bright days (Crooker and Price, 1975; Penn, 1979). The Statistical Package for Social Sciences (SPSS PC+) was used for data analysis.

The variables were entered based on Data Entry II. The amount of exposure to aircraft noise is measured using different units (NNI, NEF, Ldn, CNEL) as recommended by authorities in various countries (Hade and Bullen, 1982; Mulholland and Attenborough, 1981; Shepherd, 1987). NNI was selected as a suitable metric of aircraft noise assessment for the present study. It is generally accepted as a means of assessing annoyance likely to be caused by aircraft noise (Batting et al., 1980; Knipschild, 1977; Smith and Stansfeld, 1986; Watkins et al., 1981).

Results and discussion

The level of annoyance amongst residents showed 91 per cent of people are annoyed by aircraft noise with 43 per cent being “very much” affected (see Figure 1). About 75 per cent of residents have lived in the area for ten years or more. There is no evidence of a relationship between the problem of the level of aircraft noise and the length of time dwelling near Mehrabad Airport. Long-term residents are just as annoyed by aircraft noise as are new residents. Other studies (Cohen and Weinstein, 1981) demonstrate this and in Spain the neighbourhood noises were compared with satisfaction levels which were higher in quiet areas than noisy areas.

Noise has been classified on the basis of the source (traffic, aircraft, electronically produced, vocal, animal and impact sounds (such as banging doors or footsteps), and the extent of their disturbance capacity (Utley and Keighley, 1988). In France (Levy-Leboyer and Naturel, 1991) the most annoying noises were those judged to be loud, abnormal, impossible to avoid and happening at night. Feelings of annoyance may be partly caused indirectly by the subjects’ awareness of their impaired performance in noisy areas (Arvidsson and Lindvall, 1978).

The significance of aircraft noise is also illustrated by a survey conducted in the USA (Environmental Protection Agency, 1978). Here, the reasons for wanting to move from a particular place were given as day-night noise levels of (Ldn) > 68dB(A). Aircraft noise was the main problem according to most survey participants. Various other reasons respondents give for dissatisfaction include climate, the need for better living accommodation, smoke/dirt/smells and distance from work (Wilson, 1989).

In this study, the satisfaction scale ranges from “fairly” to “definitely satisfied” and is used to rate the overall response to aircraft noise of those questioned. It indicates a relationship between aircraft noise and dissatisfaction scores. The noise was assessed and was unbearable to 80 per cent of respondents (see Figure 2). It caused feelings of dislike amongst the residents towards the environment. Aircraft noise is the most important factor in feelings of dislike for their area (see Figure 3). Consequently they would prefer to move from the area because of the aircraft noise (see Figure 4).
Annoyance due to aircraft noise was rated as the biggest source of annoyance from a list of neighbourhood noises. The proportion of the total sample of respondents who are annoyed by different neighbourhood noises (see Figure 5) indicates that more than two-thirds of complaints are about aircraft noise. The most bothersome noises in this study can be divided into aircraft noise, children and people outside, traffic noise and children and adults indoors. There is a significant relationship between the degree of satisfaction about living where they are and being bothered by aircraft noise (P = 0.001). Startling sounds (P < 0.001), house vibrations (P = 0.006), communication interference (P = 0.02) from aircraft noise, fear of aircraft crashing (P < 0.001) and sleep disturbance (P < 0.001) are significant underlying reasons for aircraft noise annoyance. Therefore, annoyance derives from several aircraft noise effects.

The different indices of annoyance and the percentage of those affected indicate that aircraft noise induces different responses which prompt “annoyance” (see Figure 6).

Fear of crashing aircraft is an important cause of concern and annoyance amongst residents. This finding conforms with the results of previous research (Gunn, 1987; Moran et al., 1981; Stansfeld et al., 1985; Tracor Inc., 1971) and work on crashed and other areas around airports in America (Moran et al., 1981) and The Netherlands (Rejneveld, 1994). All interviewees were concerned but there were greater fear and annoyance amongst those in areas where there had been crashes previously. Other studies (Stansfeld et al., 1985) also confirmed that fear of aircraft crashes as a factor inducing annoyance responses to aircraft noise accentuated the belief that aircraft noise impairs health. It was also shown that complaints about aircraft noise from those who are afraid to fly or who fear the threat of aircraft crashes and damage to their homes relate more to the significance of the noise than its intensity (Broadbent, 1980).

The fear of aircraft crashes is a psychosocial factor among residents around airports. It is an important factor for generating annoyance to aircraft noise and the belief that it impairs health (Gunn, 1987; Stansfeld et al., 1985). The factors which could be a cause of aircraft noise reaction were studied around seven major airports in the USA (Tracor Inc., 1971). Fear of aircraft crashing was the most important factor influencing reactions to aircraft noise. Aircraft noise in these situations induces fear and a sense of insecurity which are two important aspects affecting psychological health and the quality of life (Hade and Bullen, 1982).
In this study, the different scales ranging from “not at all” to “very often” were used to rate the fear of aircraft crashing when flying overhead. It indicates that 68 per cent of people also fear aircraft noise because of their concern about the risk of crashes. There is a significant relationship between the fear of aircraft crashing and the extent of aircraft noise disturbance amongst the residents. When houses vibrate there is a significant fear of a crash ($P < 0.001$) and those affected report significantly greater aircraft noise annoyance than those who are unaffected ($P < 0.001$). There is an association between the fear of aircraft crashing and psychophysiological symptoms (startling, $P = 0.002$; headaches, $P = 0.02$; tiredness and fatigue, $P < 0.001$; tenseness and nervousness, $P = 0.004$).

Of those questioned 95 per cent believe that aircraft noise threatens their health “a little” to “very much” with 57 per cent rated “very much”. The perception of aircraft noise being harmful correlates positively with the extent of dissatisfaction, $P < 0.001$; fear of crashing, $P = 0.004$; sleep disturbance, $P < 0.001$; nervousness, $P = 0.01$ and annoyance, $P < 0.001$. This confirms previous studies (Cohen and Weinstein, 1981; Garcia et al., 1988) and indicates the importance of the respondents’ perception of the noise they experienced.

Better educated residents are more worried about health effects of aircraft noise. Irritability, headaches, depression and the desire to escape from the noise are the classic symptoms of noise annoyance (Loeb, 1986). According to Penn (1979), residents around Hamburg and Munich airports suffer nervousness as a result of aircraft noise. The result of this study shows a significant association between being startled and perception of aircraft noise danger ($P < 0.001$). Startling is a significant factor for dissatisfaction with aircraft noise ($P < 0.001$), annoyance ($P < 0.001$), nervousness ($P = 0.04$) and tiredness/fatigue ($P < 0.001$).

**Conclusion**

Data gathered in the present study, together with interim results of other studies in France, The Netherlands, Germany and Japan, show that annoyance increased with increasing number of over-flights and noise level (Ohrstrom and Bjorkman, 1978). There was a high correlation at four French airports between the average figures of the annoyance scores and noise level (Bugliarello et al., 1976). Noise level is the most important variable in determining annoyance (Cheifetz and Borsky, 1990).

Comparisons of aircraft noise in different areas around Mehrabad Airport suggest that the higher noise levels contribute most to annoyance (see Figure 7). The overall conclusion prompted by this study is that aircraft noise is a significant environmental problem which has negative effects threatening human health and which requires effective controls through more consideration in future city planning.
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