IN THE NAME OF GOD

THE MERCIFUL, THE COMPASSIONATE

IN MEMORY OF SHAHIDAN (MARTYRS)

KOOROSH (ABDOLLAH), MASOOD, AND SHAMSHIR NARAKI

TO

MY WIFE

MAHIN

MY DAUGHTERS

NASIBEH, MANSOOREH AND HONEYEH

PSYCHOLOGICAL AND SOCIAL EFFECTS OF NOISE FROM AIRCRAFT AT TEHRAN INTERNATIONAL AIRPORT (IRAN)

THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

BY

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CONTENTS

	PAGES
Contents	i
List of Tables	iv
List of Figures	vi
Acknowledgements	xiii
Glossary of Abbreviations	xv
Declaration	xvi
Abstract	xvii
CHAPTER I INTRODUCTION	**1**
Definition of noise	2
Sources of noise	4
Sources of aircraft noise	7
Importance	12
Significance of aircraft noise	15
Significance of Iran study	19
CHAPTER II MATERIAL AND METHODS	**21**
Questionnaires	22
Sound Level Meter	24
Software used in this research	25
Aircraft noise assessment	25
Noise Metrics	27
Significance of Noise Metrics	30
Metric used for this research	31

CHAPTER III HISTORY OF AVIATION IN IRAN 33

Iran Aviation history 34

CHAPTER IV NOISE AND SLEEP 47

Introduction 48

Effects of noise on sleep 50

After effects of sleep deprivation 56

Results and discussion 58

CHAPTER V NOISE, HEARING AND COMMUNICATION INTERFERENCE 67

Ear structure 68

Threshold of hearing 70

Hearing loss 72

Noise-induced hearing loss 74

Noise and communication 78

After effects of hearing and communication interference 79

Psychological after effects of hearing loss 82

psychological after effects of communication interference 84

Results and discussion 85

CHAPTER VI NOISE AND PERFORMANCE 98

Effects of noise on performance 99

Results and discussion 104

CHAPTER VII NOISE AND ANNOYANCE 113

Introduction 114

Noise effects 114

Results and discussion 123

CHAPTER VIII NOISE AND MENTAL HEALTH 152

Psychological effects of noise 153

Psychophysiological effects of noise 157

Psychiatric disorders 164

Results and discussion 169

CHAPTER IX RESULTS AND CONCLUSIONS 187

Education 188

Sleep, relaxation and peace of mind 190

Annoyance and other health effects 192

CHAPTER X RECOMMENDATIONS 197

Common noise control 198

Noise control at source 200

Noise paths 201

Noise control at receiver 202

Aircraft noise recommendations 205

Control through technical means 207

Control through planning 210

Legislative control 214

Aircraft noise certification 224

Cost of reducing aircraft noise 228

Health recommendations 233

REFERENCES 236

APPENDICES 275

Appendix A some typical noise indices 276

Appendix B questionnaires 277

Appendix C questionnaires in Farsi 292

Appendix D noise effects flowchart 303

Appendix E a disk with original statistical data (back of the cover)

LIST OF TABLES

Table 1 Some typical noise levels close to source noise . 5

Table 2 The average decibel level of various sounds . 6

Table 3 Iran Airways operation (1980-1988) 39

Table 4 Mehrabad Airport revenue operation (April 1989-March 1990). 40

Table 5 Mehrabad Airport landings and take offs (April 1989-March 1990). 40

Table 6 Comparison of Mehrabad Airport daily take offs and landings with other Iranian large airports. 42

Table 6 (continued) 43

Table 7 Percentages of disturbances in different areas. 66

Table 8 Comparative analysis of aircraft noise annoyance for British, United States and Iran airports. 143

Table 9 Teachers' disturbances at studied areas. 146

Table 10 Comparative percentages of psychological and psycho-physiological problems due to aircraft noise in different areas. 184

Table 11 Permissible noise exposure. 199

Table 12 Aircraft noise levels at certification measurement points 208

Table 13 Land use compatibility with yearly day-night average sound levels. 212

Table 14 Airline noise data . 226

Table 15 Turbojet powered aircraft. 230

LIST OF FIGURES PAGES

Figure 1.1 Sources of airframe noise. 8

Figure 1.2 Turbojet engine schematic. 9

Figure 1.2.1 Section through a turbojet engine illustrating sources of noise. 9

Figure 1.3 Turbofan engine schematic. 10

Figure 1.3.1 Section through a turbofan engine illustrating sources of noise. 10

Figure 2.1 Studied areas. 26

Figure 3.1 A representation of the legend of King Kawus who harnessed bird-power. 36

Figure 3.2 Prototype of the Iranian Fajr two-seater light aircraft. 38

Figure 3.3.	Prototype of the Sayedo Shohada Zafar 300.	38
Figure 3.4	Mehrabad Airport take-offs and landings (1970-1991).	44
Figure 3.5.	Iranian large airports' take-offs and landings " daily" (1991).	45
Figure 3.6	Domestic and international routes of Iran Airways.	46
Figure 4.1	Aircraft noise problems (sleep disturbances).	59
Figure 4.2.	Main reasons for difficulty in getting to sleep.	60
Figure 4.3.	Reasons for waking up.	61
Figure 4.4.	Reasons for sleep with windows closed in summer.	62
Figure 4.5	Education level and sleep disturbance.	64
Figure 4.6.	Occupation and sleep disturbance.	65
Figure 5.1	Ear structure	69
Figure 5.2	Simplified diagram of the ear.	69
Figure 5.3	Cross-section of the cochlea.	69
Figure 5.4	Teachers' problems due to aircraft noise.	87

Figure 5.5	Teachers' problems (male/female).	88
Figure 5.6	Teachers' problems (different grades).	89
Figure 5.7	Communication interference due to aircraft noise amongst the residents.	90
Figure 5.7.1	Communication interference (single/married).	90
Figure 5.7.2	Communication interference and education levels.	91
Figure 5.7.3	Communication interference and occupations.	92
Figure 5.8.	Lessons' abandonment due to aircraft noise.	94
Figure 5.9.	Degree of abandonment (male/female).	95
Figure 5.10	Degree of abandonment at different grades.	96
Figure 5.11	Degree of abandonment at studied areas.	97
Figure 6.1	Changes whilst teaching due to aircraft noise.	105
Figure 6.2	Changes due to aircraft noise (male/female).	107
Figure 6.3	Changes due to aircraft noise (different grades).	108
Figure 6.4	Pupils behaviour due to	

	aircraft noise (different grades).	109
Figure 6.5	Teaching problems due to aircraft noise and years of service.	111
Figure 6.6	Teaching problems and years of service at studied areas.	112
Figure 7.1	The degree of annoyance among the teachers (in number).	124
Figure 7.2	The degree of annoyance among the teachers (percentage).	124
Figure 7.3	Gender differences to aircraft noise annoyance (teachers).	125
Figure 7.4	Teachers annoyance at different grades.	126
Figure 7.5	Residents' annoyance to aircraft noise (in number).	127
Figure 7.6	Residents' annoyance to aircraft noise(percentage).	127
Figure 7.6.1	Degree of annoyance and length of dwelling.	129
Figure 7.6.2	Degree of annoyance amongst the residents (single/married).	130
Figure 7.6.3	Degree of annoyance and education level (highly annoyed).	131

Figure 7.6.4	Degree of annoyance and occupations (high annoyed).	132
Figure 7.7	Degree of enjoyment amongst the residents.	133
Figure 7.8	Degree of satisfaction to aircraft noise.	135
Figure 7.9	Reasons for dislike of area (residents).	136
Figure 7.9.1	Reasons for "wanting to move".	137
Figure 7.10	Comparison of nuisance due to neighbourhood noises.	138
Figure 7.11	Percentage of fear of aircraft crashing amongst the residents.	139
Figure 7.12	Children fear of noises.	141
Figure 7.13	Different indices of aircraft noise annoyance amongst the residents.	142
Figure 7.14	Comparison of degree of annoyance at different areas.	145
Figure 7.15	Perception of residents to aircraft noise problems.	147
Figure 7.15.1	Perception of aircraft noise effects and education levels.	148
Figure 7.16	Residents' self-reported noise	

	sensitivity.	150
Figure 7.17	Gender differences to noise sensitivity.	151
Figure 8.1	Tiredness amongst the teachers (due to aircraft noise).	171
Figure 8.1.1	Degree of tiredness amongst the teachers at different noise levels.	172
Figure 8.2	Headaches amongst the teachers (due to aircraft noise).	171
Figure 8.2.1	Comparison of headaches amongst the teachers at different noise levels.	173
Figure 8.3	Psychophysiological problems due to aircraft noise amongst the residents.	175
Figure 8.4	Psychophysiological problems due to aircraft noise (male/female).	176
Figure 8.5	Psychophysiological problems due to aircraft noise (single/married).	177
Figure 8.6	Psychophysiological problems due to aircraft noise (education level).	178
Figure 8.7	Psychophysiological problems due to aircraft noise (occupations).	179

Figure 8.8 Psychological problems due to aircraft noise (residents). 180

Figure 8.9 Psychological problems due to aircraft noise (single/married). 181

Figure 8-10 Psychological problems due to aircraft noise (occupations). 182

Figure 8.11 Psychological problems due to aircraft noise (education level). 183

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GLOSSARY OF ABBREVIATIONS

ANOMS	Airport noise and operations monitoring system
ASHA	American Speech-language-Hearing Association
CAN	International committee on aircraft noise
dB	Decibel
dB(A)	A-weighted sound level in decibels
EPA	Environmental Protection Agency
EPNdB	Effective perceived noise level in decibels
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
Hz	Hertz. cycles per second. the standard measure of sound frequency
IATA	International Aviation Transportation Association
ICAO	International Civil Aviation Organization
Ldn	Day-night average sound level
Leq	Energy mean or equivalent sound level
MNRs	Minimum Noise Routes
NEF*	Noise exposure forecast
NNI	Noise and number index
OECD	Organization for economic co-operation and Development
OSHA	Occupational Safety and Health Administration
PNdB	Perceived Noise in decibels
W.H.O.	World Health Organization

* Noise indices, Appendix A (p. 276)

DECLARATION

I declare that the study presented in this thesis is the result of my own investigation, and has under no circumstance been submitted in candidature for any other degree.

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ABSTRACT

This thesis is the result of over 2 years research on the effects of aircraft noise on human health of the residents around Mehrabad Airport (Tehran). Other studies in England, Germany, France, Netherlands, Switzerland, Hong Kong, U.S.A., Australia, Nigeria and Canada show a positive correlation between the extent of social and psychological disorders and aircraft noise.

Social survey data from questionnaires translated into Farsi highlight relationships between noise and psychological problems. The Noise and Number Index (NNI) for aircraft noise assessment was derived from noise measurements and correlated with questionnaires. The results were computed by SPSS PC+ software. The analysis of questionnaires data demonstrates that aircraft noise exposure causes annoyance and increases tiredness and affects the efficiency and performance of school teachers. Aircraft noise effects are the most severe of noises experienced by residents. It causes psychological and physiological disorders, sleep disturbance and communication difficulties.

Noise is a very important factor which needs more attention and further study on its effects on human health and the impact of aircraft noise on different sections of society.

CHAPTER I INTRODUCTION

CHAPTER I INTRODUCTION

Numerous factors threaten human health. These include Biological (viruses, bacteria, helminths and other parasites), chemical (heavy metals and organic carcinogens) and physical factors (heat, cold, air pressure, vibration and noise). Man always attempted to ward off these threats to healthy life.

To help achieve this, scientists have investigated the causes, prevention and treatment of diseases. These successes reduced the death rate and consequently human life span has increased and suffering has been reduced. Still there are many diseases with unknown aetiology. In recent years there has been growing interest in the effects of environmental stressors on the physical and emotional well-being of individuals. A physical stressor that has received increasing attention and which might have contributed to a number of human disorders is "Noise" (Kelly, 1986). This research aims to explain the link between "Noise" and human health.

Definition of Noise

Noise is commonly defined as unwanted sound (Mclean and Tarnopolsky, 1977). This can be described as rapid

pulsation in air pressure produced by a vibrating source (King and Magid, 1979). Moreover, noise is a psychological concept and defined as sound that is unwanted by the listener because it is unpleasant, bothersome, interferes with important activities or is believed to be physiologically harmful (Cohen and Weinstein, 1981; Kryter, 1970). Some workers have labelled noise as an unwanted by-product of urbanization and industrialization. As such, noise is a pervasive aspect of many modern communities and work environments (Dejoy, 1984).

The intensity of sound is commonly expressed in decibels. Zero dB(A) is about the level of the weakest sound that can be heard by a person with very good ears in an extremely quiet environment (Cohen, et al. (1981). The different frequency ranges are known respectively as the A, B, C and D scales (Fraser, 1989). The A scale indicates that frequency as well as intensity of the sound has been taken into account when measuring the noise level. "A" is sound which would appear approximately to the human ear. The B and C scales have less and less weighting respectively. The D scale is a special purpose scale used in acoustical research. For industrial noise investigations the A scale is by far the most commonly used. Many common commercial meters only have A scale. Virtually all noise legislation requires measurements to be conducted using the A scale (Fraser, 1989). It is adopted as the international metric for describing the noise of a single aircraft

movement and is established as the basis for quantifying the magnitude of the noise impact of a particular aircraft from footprint (Smith, 1991). Some typical noise levels close to the source of noise are shown in tables 1 and 2. The tables show how noise is expressed in *dB(A)*, but it should be noted that the decibel scale is logarithmic (Chester, 1985). A small increase in the decibel scale corresponds to a large increase in intensity. If the sound level increase by 10 dB, the amount of sound energy transmitted to the ear, increases tenfold (Pritchard, 1981). In other words, if the sound pressure wave or noise level increases from 80 dB to 90 dB, the volume of sound has increased 10 times. Each increase of 3 dB on the scale represents a doubling of sound intensity, so 93 dB is not simply a few decibels over 90, it is double the sound energy (Chester, 1985).

Sources of noise

Noise is produced by factories, automobiles, rail and air traffic and public works such as cranes, welding, hammering and boring (W.H.O, 1980). Also community noise such as from residential dwellings, neighbours, pets, television, radio, cassette players and other electronic appliances disturb our surroundings (Bugliarello, et al., 1976) even during our leisure times.

Table 1 : Some typical noise levels close to the source noise

Sound level in dB(A)	Relative sound intensity	Environmental noise
140	10^{14}	threshold of pain
130	10^{13}	jet engine,pneumatic road breaker
120 Deafness range	10^{12}	jet take off at 200 feet, loud motor born power press,hand grinding
110	10^{11}	riveting machine
100	10^{10}	inside underground train, circular saw, sheet metal shop
90 Risk range	10^{9}	inside noisy bus, heavy machinery
80	10^{8}	average traffic on street corner
70	10^{7}	vacuum cleaner
60	10^{6}	average conversation, a busy office
50 Safety range	10^{5}	light traffic(living room in suburban area
40	10^{4}	library
30	10^{3}	bedroom at night
20	10^{2}	broadcasting studio
10	10	sound proof room
0	1	threshold of hearing

(Data from Penn, 1979; King and Magid, 1979; Cohen, et al., 1981; Chester, 1985; Smith, 1989).

Table 2: The average decibel level of various sounds (source : Cone and Hages, 1984)

Source	dB(A)	Comments
Normal breathing	10	lowest audible level
Faint whisper	20	
Room in quiet house at midnight	30	
Easily audible whisper	40	
Average quiet house	45	
Average office(few machines	50	
Window air conditioner	55	
Conversational speech	60	
Busy restaurant	65	level of possible annoyance
Loud speech	70	
Alarm clock	75	
Inside an auto on a free way	80	
Loud orchestra music in a large room	85	
Food blender	90	
Power lawn mower	95	
Noisy construction site	100	
Motorcycle	105	
Air hammer	110	
Diesel truck accelerating	115	
Loud rock band	120	
Hydraulic press	130	
Rifle	140	usual threshold of pain
A jet plane, up close	150	
Cap pistol	160	
Wind tunnel	170	eardrums can burst
	180	
Rocket engine nearby	190	

Sources of aircraft noise

The introduction of turbo jet-powered aircraft on commercial routes in the 1950s along with increased services, caused an increase in the proportion of population exposed to high levels of aircraft noise (Wilson, 1989). The major source of noise from a jet aircraft on landing and take off is the aircraft power plant, although aerodynamic noise caused by air flow over the air frame (Fig. 1.1) can influence the overall noise signature during the approach to land (Nelson, 1987). Advances in engine technology over the past 20 years have reduced engine noise to the point where the engine and the airframe are now about equal contributors to aircraft noise on landing. However the engine is still the major noise source on take off (Wells, 1986).

Turbo jet engine

The principal sources of noise in jet engines are, 1) the fan, 2) the compressor and turbine, 3) the exhaust (Wells, 1986). Jet engines produce propulsion by accelerating the mass of air through them. In the earlier turbo-jet engines, air is compressed in a mechanical compressor, heated in a combustion chamber and then accelerated by expansion through the jet nozzle (Fig. 1.2). The expanding gas also

drives a turbine which, in turn, drives the compressor (Fig.1.2.1). These processes produce three type of noise: 1) inlet noise radiated from the air intake, primarily as a result of compressor noise plus aerodynamic noise; 2) vibrations resulting from the body of the engine, which are generally of minor importance; and 3) exhaust noise which may include a mixture of internally generated noise from the compressor and turbine and high-velocity jet mixing noise generally termed aerodynamic jet noise. For the turbo-jet engine, aerodynamic jet noise is by far the most important noise source and it is only at very low engine powers that other sources become predominant (Nelson, 1987).

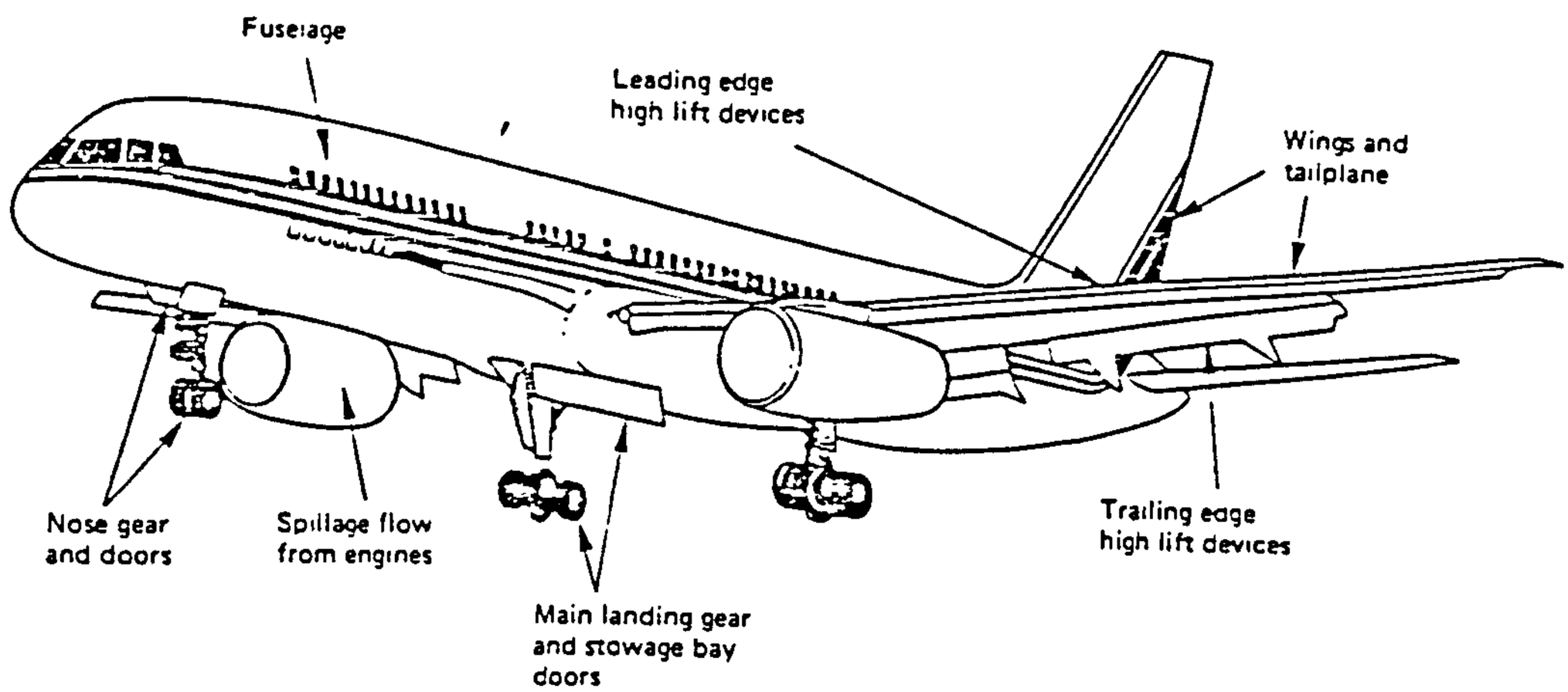

Fig. 1.1 : Sources of airframe noise

(source : Nelson, 1987)

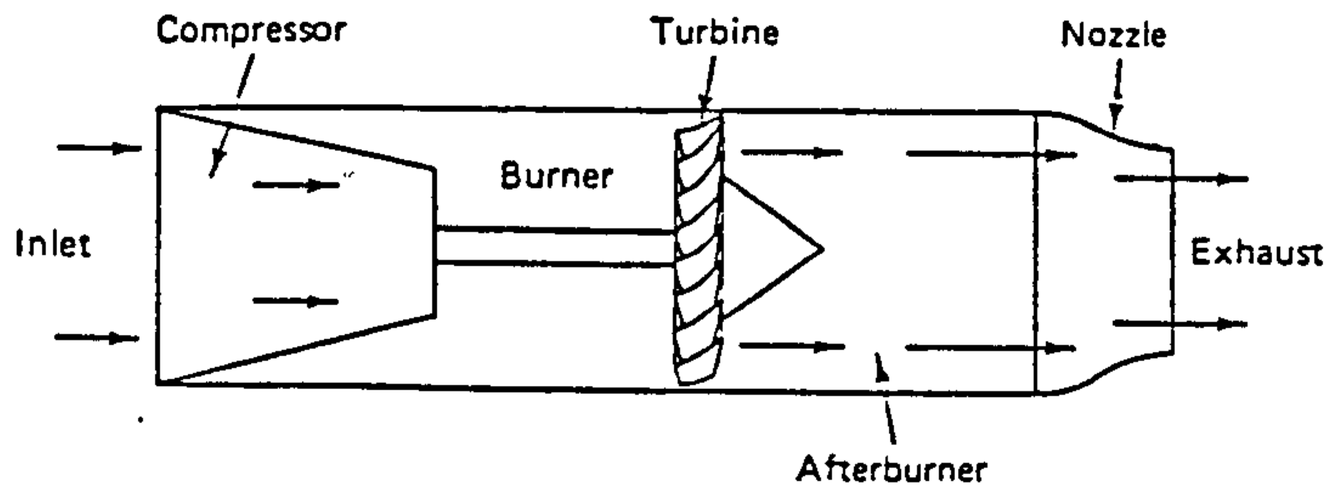

Fig.1.2 : Turbojet engine schematic

(source : Wilson, 1989)

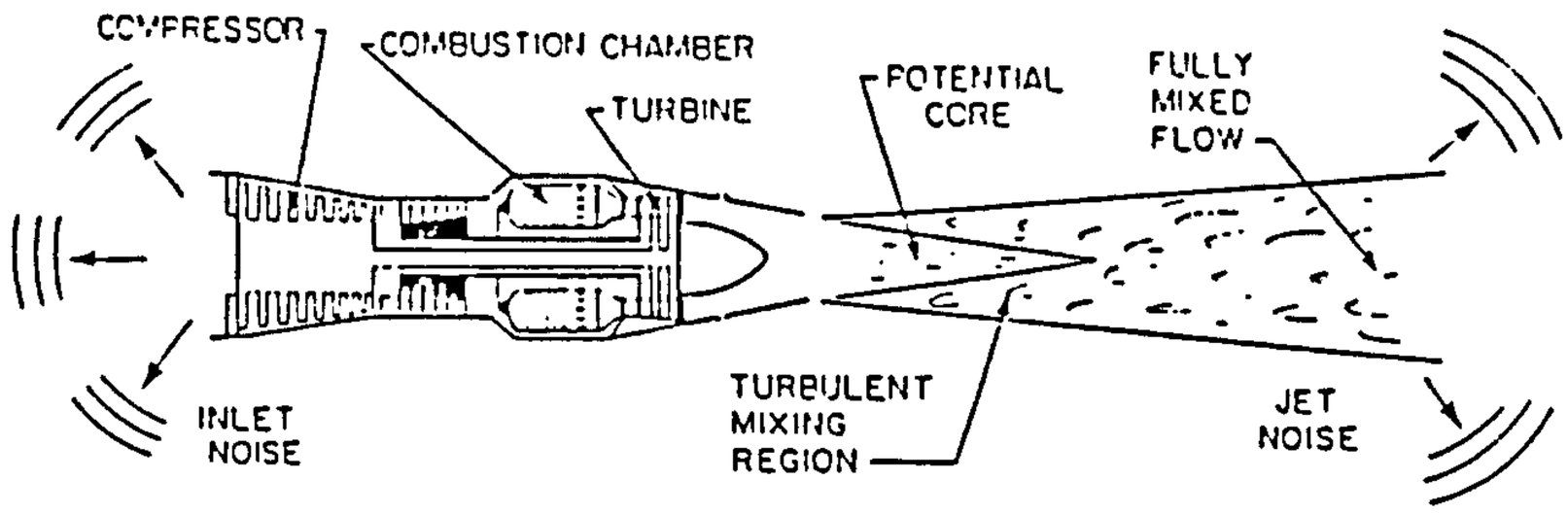

Fig.1.2.1 : Section through a turbojet engine illustrating sources of noise (source : Raney and Cawthorn, 1979)

Turbo-fan engine

The turbo-fan engine design introduces a multibladed turbine driven fan before the compressor section (Fig.1.3). The turbo-fan engine (Fig.1.3.1) differs from the turbo-jet engine in two important respects, first, the turbo-fan

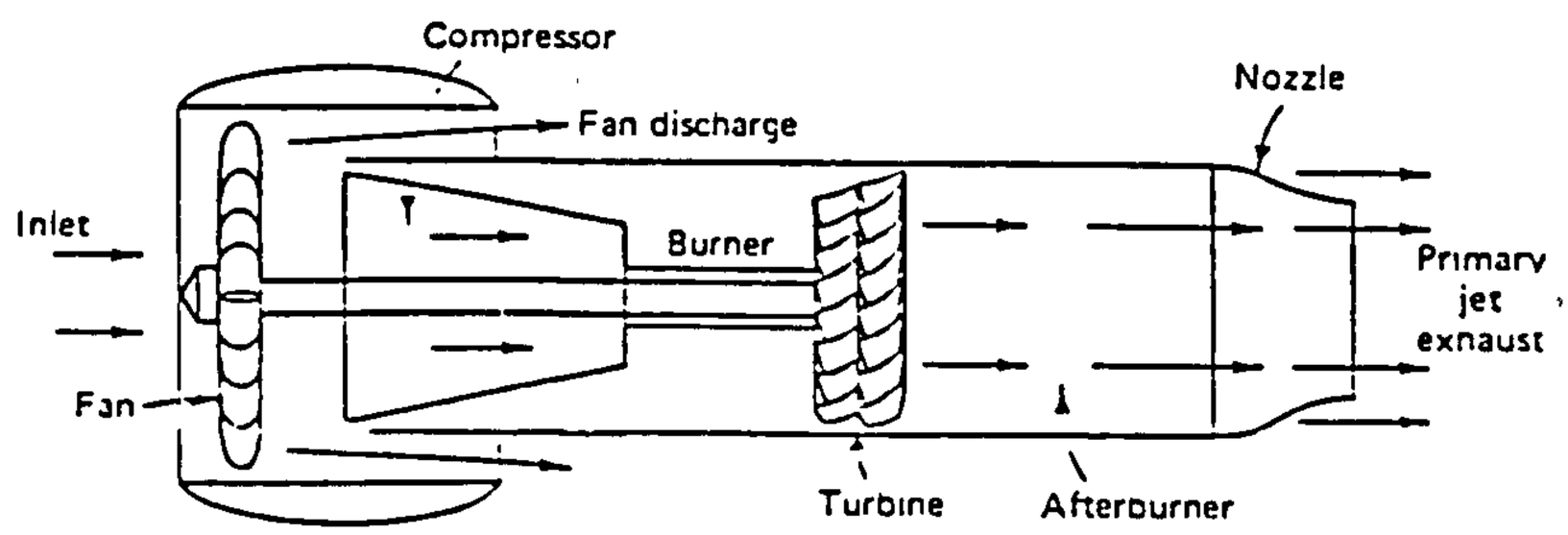

Fig. 1.3 : Turbofan engine schematic (source : Wilson, 1989)

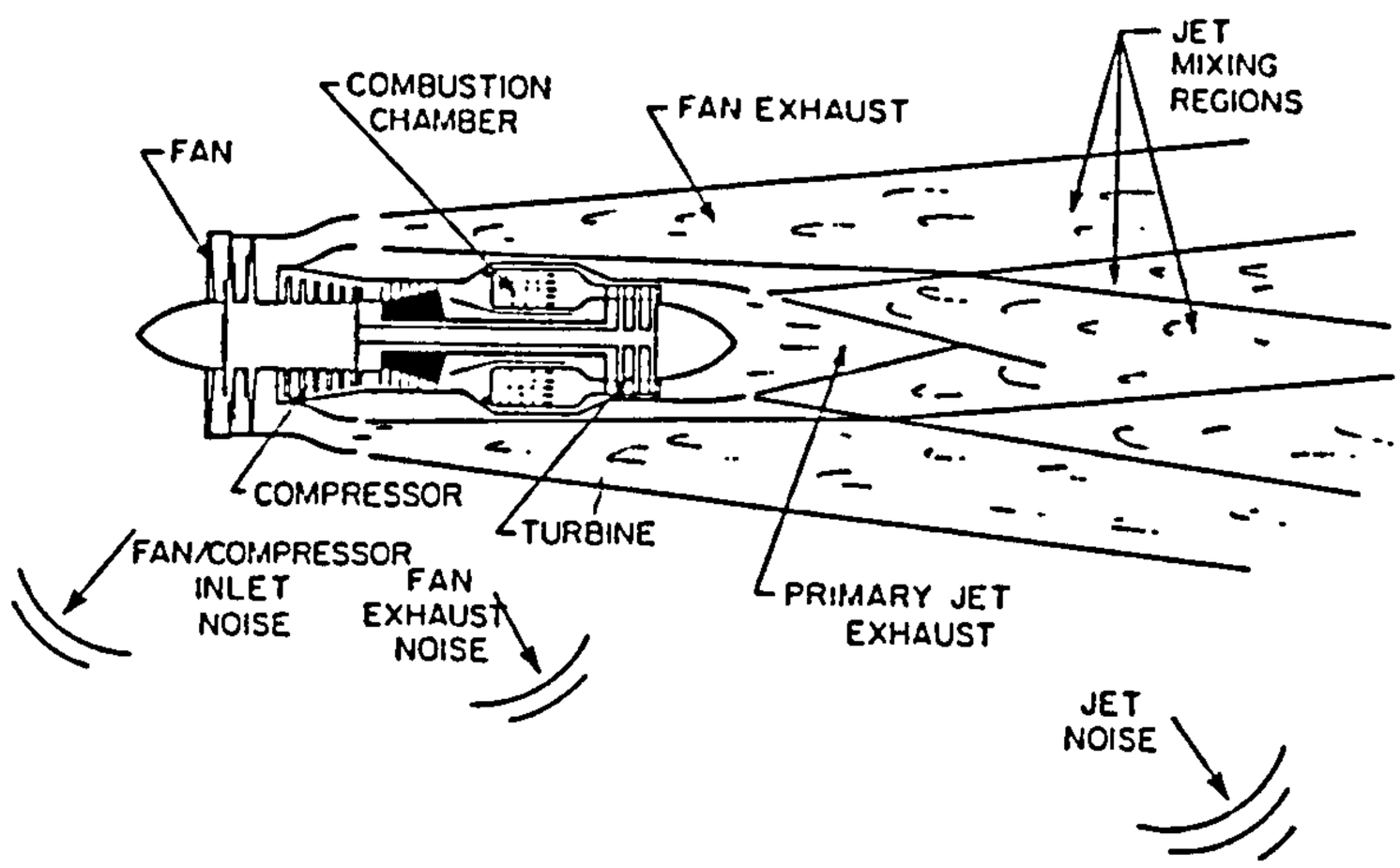

Fig. 1.3.1 : Section through a turbofan engine illustrating sources of noise (source : Raney and Cawthorn, 1979).

engine incorporates a thrust-producing fan, second, the turbo-fan engine produces a lower jet-exhaust velocity than the aerodynamic-jet-noise-dominated turbojet engine and is therefore capable of quieter operation for a given total thrust (Raney and Cawthorn, 1979).

Propeller aircraft noise

The noise from propeller driven aeroplanes is a combination of two main sound sources, the propeller and the power plant. For most practical conditions, propeller noise is the more important noise source (Nelson, 1987). Propeller-driven aircraft are common for general aviation, which includes corporate and private operations, but little used by commercial airlines (Wilson, 1989).

Super-sonic aircraft and sonic boom

Typical commercial airliners fly at speeds of about Mach 0.84, where Mach 1 is the speed of sound propagation at the flight altitude. Some military aircraft and a few commercial aircraft fly at supersonic speeds, that is, at speeds greater than Mach 1 (Wilson, 1989). Supersonic aircraft produce shock waves or pressure pulses called sonic booms which cover a wide area under flight path.

Importance

Noise is a form of air pollution which affects the quality of life (Mulholland and Attenborough, 1981). It is a serious problem for a large proportion of urban populations (Garcia, et al., 1988). Even after more than thirty years of noise research and noise abatements, noise is still an urgent environmental problem (Paechter, et al., 1988). It is increasingly evident that high exposure to noise has adverse psychological and physiological effects (Wells, 1986).

Noise can disturb work, rest, sleep and communication and damage hearing (W.H.O., 1980). A causal relationship between noise exposure and hearing loss has probably been recognized for thousands of years (Stream, 1980). This is due to factories or industrial and natural sources. According to Kryter (1980), based upon the study of Rosen (1974), the natives living and fishing near the falls and rapid of the upper Nile became deaf from the roar of water. In other circumstances a primitive Egyptian Tribe (Maabams) had hearing acuity superior to that of Americans in all age groups (Egunjobi, 1990). A seventy-year-old Maabam could hear as well as a young American boy. He attributed this to the relatively quiet Maabam environment compared to the U.S.A.

Industrial development has increased environmental noise resulting in danger to hearing. In addition, numerous psychological problems are linked with hearing loss. Mclean and Tarnopolsky (1977) observed that there was an indirect connection between noise and mental illness via noise-induced deafness. They proposed that there was a high rate of probability between mental illnesses and deafness in community as well as hospital populations. Moreover, deafness isolates children and adults from the community. Certainly isolation will cause some other problems. Accident potential may also be increased by noise-induced hearing loss (Dejoy, 1984). Noise causes accidents when interfering with spoken communication and warning signals and leads to accidents where it reduces the morale, efficiency and general awareness of workers (King and Magid, 1979). An increase in mortality rate (5%) due to increases in number of fatal diseases around Los Angeles Airport (LAX) has been reported by Meecham and Shaw (1988). Noise not only damages hearing and causes secondary effects but it can create physical and psychological, physiological, sleep disturbances, communication interference and work and performance disorders (Stream, 1980; Dejoy, 1984; Smith and Stansfeld, 1986).

In animals a higher rate of stillbirths, deformities, increase in prenatal mortality and decrease of height and weight of new-born has been noted due to noise (Rehm and Jansen, 1978).

In recent public opinion polls in France and Japan noise was rated a more serious concern than air pollution. Noise has been ranked as the most annoying single environmental problem (Alexandre and Barde,1981). There is little evidence that people adapt to noise in residential settings (Cohen and Weinstein, 1981). Long time neighborhood residents are at least as bothered by noise as more recent arrivals. People do not adapt to noise as easily as is commonly believed (Weinstein, 1982).

All sources of noise can disturb sleep (Nelson, 1987). It leads not only to behavioral difficulties (awakening, difficulties in falling asleep), but causes physiological changes which reduce the quality of sleep (Bugliarello, et al., 1987).

Field studies on aircraft noise showed that there was no relationship between noise disturbance and the length of residence. However, there is a little evidence only for physiological adaptation . Even if we agree reduction in physiological disturbance, the performance of people during the day following exposure to noise at night is still affected (Nelson, 1987). Noise disturbance also increased with length of residence (Weinstein, 1982).

Significance of aircraft noise

Aircraft noise is probably the most dramatic of the man-

made noise sources that are heard by the general community particularly in the vicinity of an airport (Mulholland and Attenborough, 1981). Efforts to understand the psychological and physiological consequences of escalating noise pollution have intensified over the past decade and an especially relevant area is the impact of noise on communities surrounding airports (Jue, et al., 1984).

The first serious studies of the effect of aircraft noise on residential population were conducted in the United States of America in the 1950's with interviews around major airports. The first study of aircraft noise in U.K. as a psychological reaction to aircraft noise, was conducted in London Airport (Heathrow) in 1961 and 1967 (Hede and Bullen, 1982). In England noise complaints received by local authorities have increased threefold since the control of pollution Act was introduced in 1976 to deal with noise problems (Barrett, 1991). A study in Hamburg (Germany) by Rohrmann (1978) showed 90% of people who were interviewed rated environmental noise as annoying. They were asked about unpleasant types of environmental noise. The greatest number of respondents answered aircraft noise , even if they did not live near an airport. Ambient city noise in many areas of U.S. A. has doubled in 20 years and another investigation estimates that ambient city noise in Canada increases a half-decibel a year (Egunjobi, 1990). Aircraft noise, especially the noise of jet aircraft is the most common subject of complaint by airport neighbours

(Wells, 1986). In U.S.A. aircraft noise has become increasingly prevalent in communities as a result of advances in technology and increased air travel. Commercial operations have been increasing annually by nearly 40.000 since 1963 (Tracor Inc. 1971). 85% of residents around Southern California Airport also rated aircraft noise as a problem in their neighbourhoods (Jue, et al., 1984). The unbearable aircraft noise from Hong Kong International Airport which is situated in the city centre, affects about half a million people in the vicinity (Jim, 1992). In the 24 countries which belong to the Organization for Economic Cooperation and Development (OECD), the total noise emitted has doubled since 1960 due primarily to two factors, air traffic and road traffic. Aircraft has increased 10 times and the number of motor vehicle has tripled (Alexandre and Barde, 1981). 100 million people belong to OECD nations and are exposed to unacceptable noise levels.

The measured average noise reduction of front yard and back yard noise for residence, using passing street vehicles as noise sources, were 17 and 21 *dB(A)*. For aircraft overflights the average measured noise reduction (difference between front yard and back yard) was found to be 0.2 and 0.4 *dB(A)*. Therefore the measurements show that acoustical factors around residences in front and back yards are generally different for street traffic noise but not for aircraft overflight noise (Ortega and Kryter, 1982).

The interim result of studies by Ando and Hattori (1977) around Tokyo airport showed a lower birth weight among the infants born to mothers living in noisy areas compared to those born to mothers from quieter areas. In Dusseldrof (Germany) (Rehm and Jansen, 1978) a tendency towards an increased rate of premature birth was found in noisy areas, though the difference with quieter areas was not significant. A greater number of abnormal births to mothers living in the noisiest area around Los Angeles International Airport was found by Jones and Tauscher (1978) (quoted by Clark, 1984). Any annoyance experienced by the human mother is likely to be transmitted to the developing foetus in some form or other, but the extent to which noise stress can actually cause low birth-weight is open to debate (Clark, 1984)

A series of medical effects of aircraft noise in the Netherlands (Knipschild, 1977 VIII) showed that aircraft noise constitutes a very serious threat to public health in all its aspects, affecting well-being, mental disorders, somatic symptoms and diseases.

According to W.H.O. Standards, children's health (particulary those under 1-year) is an indicator for showing the level and quality of health and development in communities . Moreover the weight of infants at birth also is a criterion for their health. If we agree that aircraft noise is a factor reducing infant weight, we will perhaps

also agree that aircraft noise is a risk factor for infants' health. However, there are some variables like, social class, nutrition, general health, age, and smoking that may influence a pregnancy (Rehm and Jansen, 1978 and Kryter, 1980). This risk factor has also been observed amongst animals.

Studies on the effects of aircraft noise on schools around Heathrow airport (Crook and Langdon, 1974) showed that aircraft noise interfered with teaching and caused dissatisfaction and more lessons being abandoned amongst teachers. Students also became noisier and less inclined to work and be active. Children living and attending elementary school under the air corridor to Los Angeles International Airport had higher systolic and diastolic blood pressure than those living in quieter neighbourhoods. Children 9-13 age years in noise impacted areas around none airports in Russia showed abnormal blood pressure, pulse and cardiac functions (Cohen and Weinstein, 1981).

It seems noise pollution is rapidly growing as a major environmental concern (Cohen and Weinstein, 1981) and it is an important factor that threatens human health and quality of life. Therefore, the concept behind medical effects due to acute exposure to noise should be the same as those used in traditional toxicology (Rylander, 1978)

Significance of Iran study

During this study there has been no record of aircraft noise research in Iran. As aircraft noise affects health it was necessary for such study.

In 1978 the W.H.O. held an international conference at Alma Ata in the U.S.S.R.; the conference was chiefly notable for statement of the goal of health for all by the year 2000, and the agreement (by 134 nations) of the declaration of Alma Ata. Iran is one of the first developing countries to build a health care system (Gann, 1986). However the conference was on primary health care, but as the importance of noise as a physical factor which threatens the human health, such studies could be useful for achieving the goal of the conference "health for all by the years 2000".

Iran like other developing countries is undergoing a high rate of urbanization. After the Islamic Revolution more attempts were made for aircraft manufacturing and the building of airports. The first aeroplane was made in Iran in 1988 and the light homebuilt jet aircraft began in 1991 (Lambert, 1992). During the first decade of the revolution in Iran (1979-1989) the number of airports increased from 22 to 28, and airports suitable for wide-body aircrafts increased from 8 to 13 (Islamic Republic, 1993). The new

Imam Khomeini International Airport (Tehran) is in construction. In government 5-year plans 22 airports will be built in different cities. This study could be used as the basis of planning procedures and schemes for this government quinquennial strategy.

CHAPTER II MATERIALS AND METHODS

CHAPTER II

MATERIAL AND METHODS

This study may provide a clue to the effects of aircraft noise on mental health, sleep disturbance, annoyance and sociopsychological activities of the residents near the airport. The effects of aircraft noise on teaching, performance and efficiency of teachers in a number of schools close to Mehrabad Airport were studied for assessing educational effects of aircraft noise.

Questionnaires

Two questionnaires were used to gather social survey data. The questionnaires were based on recommendations by Crook and Langdon (1974); Langdon and Buller (1977); Mclean and Tarnopolsky (1977); Ko (1979); Sargent, et al. (1980); Ko (1981); Tarnopolsky and Marton Williams (1980); Loeb (1981); Hade and Bullen (1982); Griffiths, et al., (1980); Jue, et al. (1984) and Diamond and Rice (1987). The questions have been set in the present context and include standard questions commonly used in these studies. Questionnaires were translated into the Persian (Farsi) so as to suit the residents and teachers near the airport. The questionnaire for residents consists of 44 questions

while the one for teachers contains 15 questions (Appendices B and C). The questionnaires are designed in a simple form so that teachers and residents would not have any difficulty in answering the questions. The residents' responses include individual perceptions on health, performance, communication, satisfaction, sleep and relaxation related to aircraft noise. The teacher respondents are mostly based on teaching, activities in schools and estimates of aircraft noise effects on pupils. For this social survey, the people have been asked to give rating of their feelings. Questions require the respondents to give a rating such as "very much", "fairly", "a little" or "very often", "quite often" and "rarely" (Appendix : B). The study excludes the subjective responses of pupils in relation to aircraft noise exposure and the effects of noise on learning, performance or other activities. 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 adapted in designing the questionnaires used in the Tehran survey.

When Mehrabad Airport was built in 1953 there was no human settlement nearby. However, due to expansion of the city the airport population clear zone in 1975 shrank to 10 Km in the West, to 4.00 Km in North, 2.00 Km in East

and to 5.00 Km in South (Iran Aviation Organization, 1991). During the present study the approximate distance to the nearest human settlement has been measured as only 500 meters.

For resident respondents 3 different residential areas were chosen (Fig 2.1) and then dwellings were randomly (Mohammad, et al., 1982) selected in each area. For teacher respondents, 8 different schools close to the airport were selected. The schools were all boys or girls and included 2 primary, 3 secondary and 3 high school. Staff were required to answer the questionnaire on their reactions to aircraft noise. 264 individuals have responded to questions (193 residents and 71 teachers).

Sound Level Meter

Two Harris Sound Level Indicators were calibrated and standardised by the department of Applied Acoustics, University of Salford to designate noise levels at studied areas. Noise measurements and social surveys were carried out at 3 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) as recommended on sunny and bright days (Crocker and Price, 1975; Penn, 1979) .

Out door aircraft noise was separated and measured independent of background road vehicle traffic noise between 06.00 to 18.00 hours daily.

Software used in this research

The Statistical Package for Social Sciences (SPSS PC+) was used for data analysis. The variables were entered based on Data Entry II and are valued (value labels). Frequencies of descriptive and statistic, tables, cross tabs, means, correlations and comparing groups (T-test) were used in data analysis. All computer printouts are available. The Harvard Graphic Package was used for graphs in this research.

Aircraft noise assessment

Some believe that night noise annoys more than day noise (Shepherd, 1987). Others argue that A-weighted noise from aircraft is more annoying than A-weighted noise from road traffic (Hall, et al., 1981). For the same value of Ldn a greater percentage of the sample is highly annoyed by aircraft noise than by road traffic noise (Hall, et al., 1981; Kryter, 1982). The A-weighting network and the annoyance is engendered by exposure, the product of duration and level give of A-weighted equivalent energy units CNEL, Ldn, these are adopted to quantify

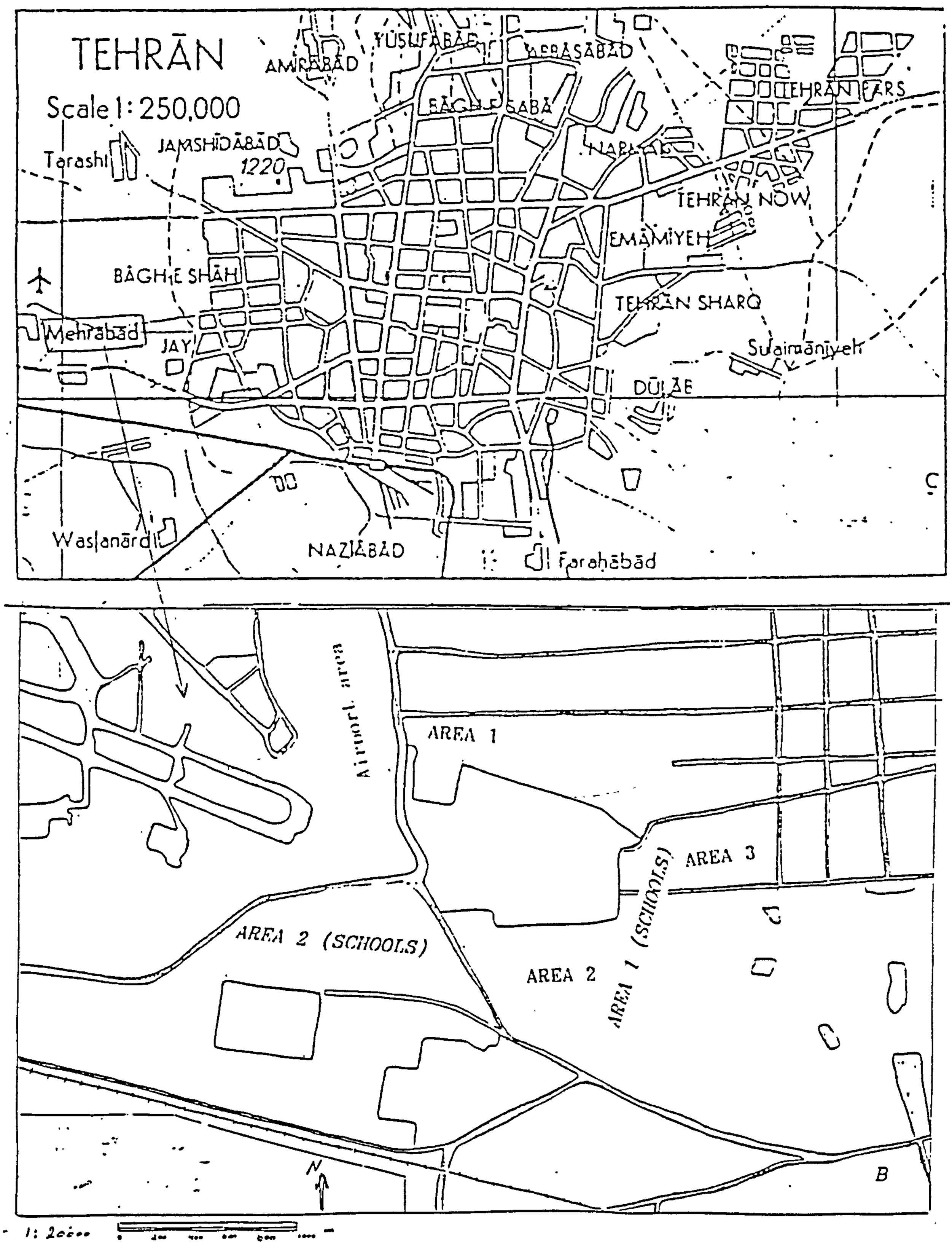

Fig. 2.1. A) Tehran Map B(studied areas

environmental noise effects (Fidell ,et al., 1985). Any type of noise can be rated by these metrics, but the target noise in most cases has been aircraft noise (Shepherd, 1987).

Noise Metrics

Noise and Number Index (NNI): provide a convenient and relatively straight forward assessment of annoyance likely to be caused by airport aircraft (Trade and Technical Ltd, 1979). NNI (averaged maximum perceived noise level modified for aircraft flying frequency) for aircraft noise assessment(Shepherd, 1987) was based upon annoyance with aircraft noise around Heathrow Airport (London) in 1961 (Mulholland and Attenborough, 1981).

NNI= average peak noise level + 15 Log N- 80

average peak noise level is dB average of maximum Perceived Noise Decibel (*PNdB*) values, N the number of aircraft during one day (06.00 - 22.00) or night (22.00 - 06.00) (Jones and Chapman, 1984). The 80 is used to obtain a convenient number. The British NNI employs an A of 15. The German index (Q) which is similar in some respects, has a coefficient of 10, other indices have employed A's ranging from 6 to 15 (Loeb, 1986). NNI is calculated for aircraft movements during 12 day-time hours between 06.00 am and 18.00 or for the 8 hours night-time between 22.00 and 06.00 am (Mulholland and Attenborough, 1981). The night

time figure is multiplied by 3/2 to account for the missing 4 hours (18.00 to 22.00). The most important factors in this index are the average peak level of aircraft noise in *PNdB* and the number of planes. *PNdB* can be measured directly by a Sound Level Meter provided with "D" weighting adding 6 or 7 to the displayed peak level. If the *PNdB* values are not available , it has to be (peak *dB(A)* + 14) (Jones and Chapman, 1984). *PNdB* is a new unit of noise to which various corrections can be applied to take account of pure tones in an aircraft noise spectrum and the duration of aircraft over-flight. The corrected tone form of the *PNdB* called the Effective Perceived Noise Decibel (*EPNdB*) is used in noise certification procedure (Mulholland and Attenborough, 1981).

Community Noise Equivalent Level (CNEL): energy-averaged A-weighted sound level over a 24 hour period. A 5 dB correction is effectively added for the hours of 19.00 to 22.00 and 10 dB is added 22.00 to 07.00 . This metric was first used in California for aircraft noise assessment (Shepherd, 1987).

Noise Exposure Forecast (NEF): Energy-averaged Effective Perceived Noise Level (EPNL) over a 24 hour period intended specifically for assessment of aircraft noise. Each noise event measurement is effectively increased by $\log^{10}$ 16.67 in the calculation procedure for the hours 22.00 to 07.00 (Shepherd, 1987).

Composite Noise Rating for Aircraft (CNRA) is based on maximum Perceived Noise Level (PNL). It is determined separately for take offs, landings and ground run-ups. Corrections or penalties are added or subtracted depending on the number of operations, season and time of day. A flat 10 dB correction is added for events which occur during the hours 22.00 to 07.00 (Shepherd, 1987).

Day-Night average Sound Level (DNL, or Ldn) : is used when night time noise is particularly objectionable in residential areas (Wilson, 1989). It provides an adequate description of integrated noise exposure produced by environmental noise sources such as aircraft and surface traffic (Green and Fidell, 1990). There is the A-weighted Equivalent Sound Level (LA eq) which accounts, on an energy basis, for sound over fixed 24 hour periods. When modified by the addition of a 10 dB night time noise penalty LA eq becomes Ldn the Day-Night average sound level. The 10 dB correction is added for evening events between 22.00 to 07.00.

Different metrics are used in other countries (Nelson, 1987). In France, the Isopsophic Index (I); Netherlands, the Kosten unit (B); Denmark, Day Night Level (DEN) and Weighted Equivalent Continuous Perceived Noise Level (WECPNL) which recommended by ICAO (Smith, 1989) is used in Italy and Brazil. Japan used this metric in modified form (appendix, A).

Significant of noise metrics

Careful noise measurement and characterization show that measures like CNR, NEF, Ldn, CNEL, which determine penalties for evening and night time noise, are based on political rather than scientific criteria (Singer and Baum, 1987). The reason is, that there are no differences in physiology or performance due to noise related to actual clock time. Noise during sleep may have a different set of effects than noise during wakefulness, but this was neither explored nor taken into account for developing of these indices. East of Los Angeles Airport the discontinuation of late-night flights over residential areas adjacent to a large airport had no appreciable short-term effect on the reported sleeping habits, communications or apprehensive in behaviour (Fidell and Jones ,1975). There was no significant effect on annoyance, whether related to speech or sleep due to aircraft noise. But, Schomer (1983) supported retention of a night time penalty in descriptors such as Ldn. Respondents were more likely to notice and be bothered by events during the night than during the day. Penalties were based on observations that sleep interference during the night is annoying. However, there was an inconsistent pattern of relationships between Ldn and highly annoyed respondents (Borsky,1983). Even if the NNI was accepted as a measure of aircraft noise annoyance, there are uncertainties in Pilot behaviour and in climatic

condition. A temperature inversion such as that which occurs on a foggy day causes aircraft noise to be heard over a much larger area than during days when there is no temperature inversion (Mulholland and Attenborough, 1981). But they agree that NNI as a metric, levels the difference between night time and day time annoyance. Disturbance of sleep is perhaps the most annoying effect of noise. However, because of problems with valid metrics for describing noise, criteria have been established for various land uses and airport operating (Shepherd, 1987). Activity compatibility can consequently be addressed in terms of a number of possible noise metrics. It is recommended that. Ldn simplicity is understandable by the scientifically unsophisticated and is relatively easy to compute.

Metric used for this research

For measuring the amount of exposure to aircraft noise, different units have been used and recommended by authorities in various countries. CNEL, was first used for aircraft noise assessment in California (Shepherd, 1987). NEF has been used by the United State Federal Aviation Agency and Australia (Hede and Bullen, 1982). NNI has been used in Britain as a metric for aircraft noise assessment (Mulholland and Attenborough, 1981; Shepherd, 1987). However Ldn and CNEL may be the best metrics for aircraft noise assessment (Department of Applied Acoustic, University of

Salford), the equipment which was used in this study was not suitable for using these metrics. Therefore, the traditional method, first carried out around Heathrow Airport (London) in 1961 (Mulholland and Attenborough, 1981) and mostly has been used in England (Shepherd, 1987) (NNI) was selected as a suitable metric of aircraft noise assessment for the present study. NNI is now generally accepted as a method of assessing annoyance likely to be caused by aircraft noise, and it has been used by many investigators (Grandjean, 1974; Knipschild, 1977; Batting, et al., 1980; Watkins, et al.,1981; Smith and Stansfeld, 1986). Government White Paper on Airport Policy (1st Feb. 1978), " its use is likely to continue into notwithstanding any shortcoming, NNI is the best available measure of aircraft noise disturbance at large international airports though not applicable for small airports (Penn, 1979). Therefore for Mehrabad Airport as an international airport it could be a suitable metric for assessing noise causing annoyance. The British (NNI) formula, the A values of 15, and the "N" was calculated for residents exposed to day-time landing and take offs from 06.00 to 18.00 . For schools, the numbers during whole school time varied between 07.00 and 15.00. The average number of daily over flights was obtained from the Airport Public Relations (Iran Air, 1991,1992).

CHAPTER III HISTORY OF AVIATION IN IRAN

CHAPTER III

HISTORY OF AVIATION IN IRAN

Iran Aviation history

The idea of flying has been seen in Iranian civilization as winged horses and human headed winged bulls situated by King Xerxes at Persepolice (Reay, 1977). The first attempt to fly was made by King Kai Kawus by four trained eagles to carry his throne (fig.3.1). At each of the four corners of the throne a javelin was stuck into the ground, its point vertical. Lamb's flesh was hung on the top of each spear, and as the eagles become hungry, so their attempts to reach the food became greater, until enough lift was generated to raise the king from the ground.

An Aviation office was first established in the Defence Ministry of Iran in 1922. A year later the government purchased seven aircraft to establish a modern air installation. Pilot candidates were sent to Europe for training and returned in 1925. The first Iranian piloted an airplane from Paris to Ghaleh Morghi Airport (Tehran) in 1926. The first balloon in Tehran was lifted by a French aviator in 1891. The first air mail was transported in 1922. A contract with a German Company that Post

Consignments from Tehran to other states were carried by German Single-Wing aircrafts (Iran Air, 1992).

The Iranian Civil Aviation Organization Law was approved in 1926 and provided autonomy to the Civil Aviation Organization lead by a Deputy Transport Minister. Iranian Airways was established in 1946. It was the only airline with responsibility for transporting passengers and cargo (Iran Aviation Organization, 1991).

An Aeronavigation faculty was established in West Tehran in 1950, and three years later (1953) Mehrabad Airport was commissioned and a new company, Persian Airways, was established for transportation of passengers and cargo.

Iran Air (the present Iranian International civil airline) was established in 1960 with 700 staff, 9 (DC-3), a (DC-6) and 3 Viscount aircraft. Handling and Dispatching of Iran Air were administrated by foreign companies like PAN AM, SAS, Swiss Air and KLM. From 1963 Iran Air managed all its activities with Iranian staff and joined International Aviation Transportation Association (IATA). The first Iran Air international passenger-flight was accomplished on the route of Tehran, Beirut, Rome, Geneva, and Frankfurt by a rental Boeing 727-100 in 1965. At that time Iran Air had got 2 Boeing 727-100, 2 Boeing 707 and 3 Boeing 737, excluding rental aircraft (Iran Air, 1992).

Fig.3.1 : a representation of the legend of King Kawus who harnessed bird-power (Source : Reay, 1977).

The first aircraft (Fajr) in Iran was made by Air industries Division of Islamic Revolutionary Guard Corps (IRGC) (Lambert, 1991). The first flight of this side by side two-seat light aircraft (Fig. 3.2) was announced in Tehran on 22 February 1988 and was to be put into full scale production shortly afterwards. It is assumed that it was intended for primary training and , possibly, in liaison or reconnaissance. A two-seater light attack helicopter (Fig.3.3) also usable for agriculture (Zafar 300) design of which was started on 20 March 1987, construction began on 21 April 1988, and the prototype made its first flight on 31 January 1989. It had completed 100 hours flying by the end of 1990. Further modifications were then under way (Lambert, 1991).

The Dorna Company established in March 1989 for the design and development of aircraft and composites technology construction of a light all-composites homebuilt jet aircraft began in 1991 (Lambert, 1992), which was due for completion in late 1992 and subsequent general aviation certification.

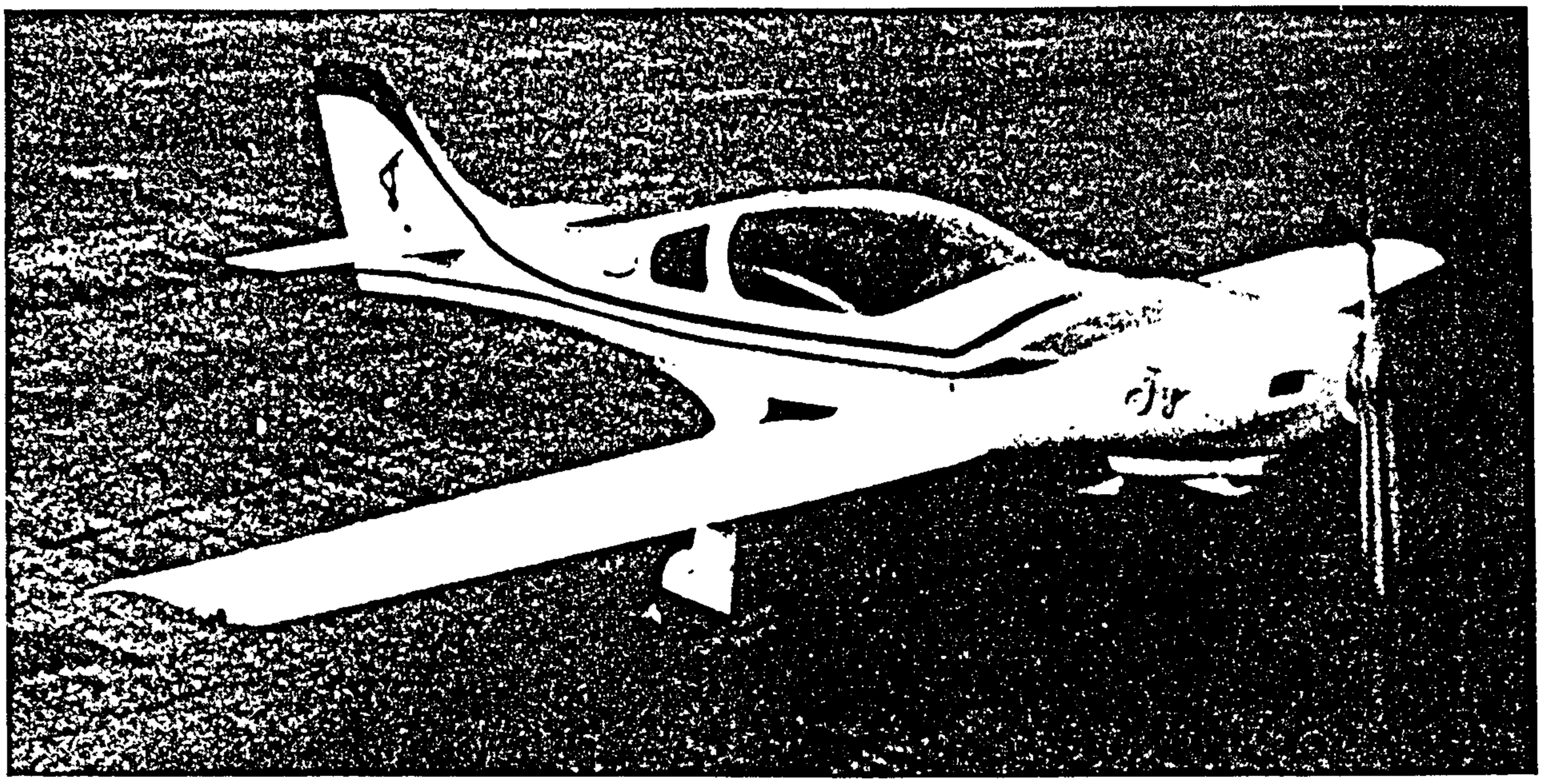

Fig. 3.2. Prototype of Iranian Fajr two-seat light aircraft (source : Lambert, 1991).

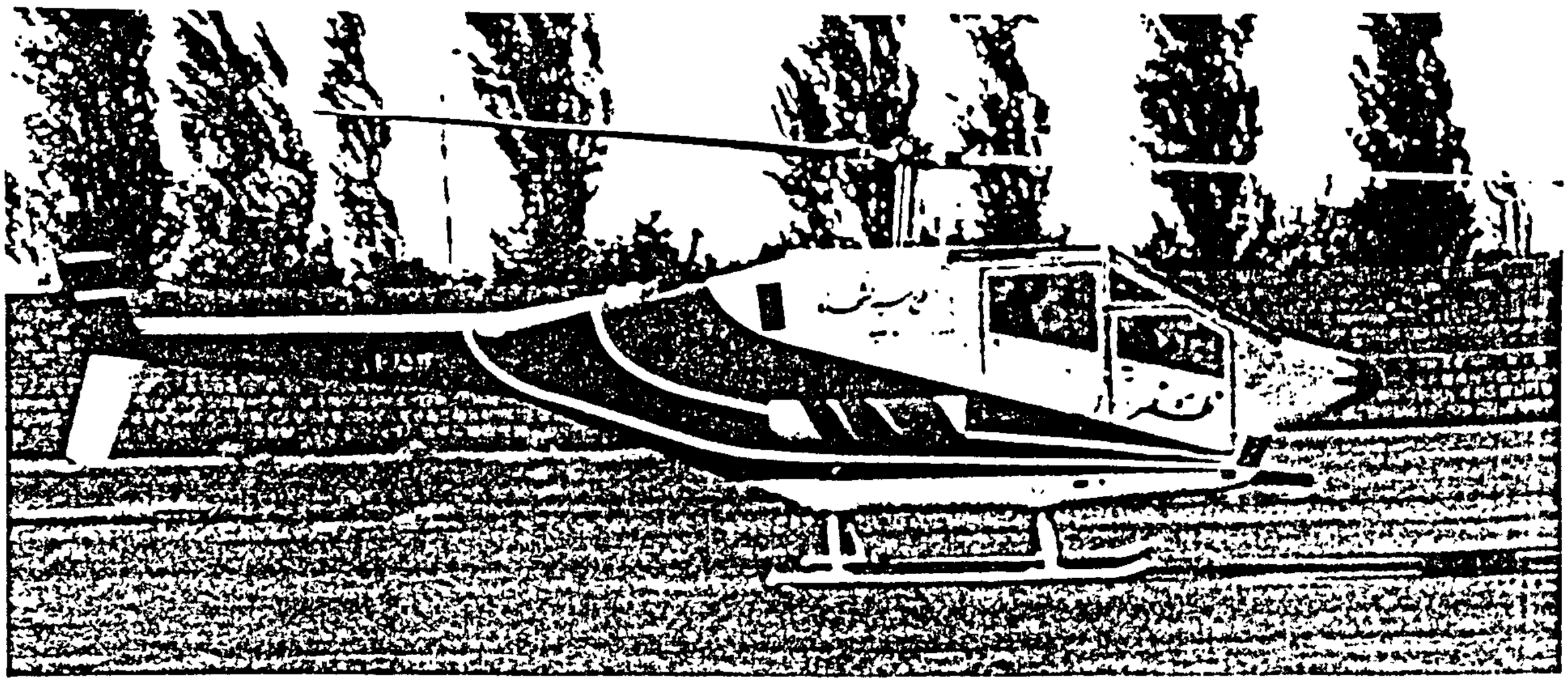

Fig. 3.3. Prototype of Seyedo Shohada Zafar 300 two-seat helicopter (source; Lambert, 1991).

Presently, "Iran Air " is responsible for transportation of passengers, cargo and post, intra-national as well as inter-national (Fig. 3.6). Besides, the Civil Aviation Company (Aseman) also operated domestic flights (Tables 3 and 4).

Table 3 : Iran Airways operation (source: International Road Transport Union, 1990)

Years	Passengers			Goods *
	Passengers carried (000)	Of which international (000)	Pass./km (000.000)	T./km (000.000)
1980	1863	259	1867	217
1983	3621	478	3334	398
1984	4039	761	4107	457
1985	3367	923	4035	410
1986	4514	912	4695	485
1987	4706	1008	4792	482
1988	4257	658	4194	502

* Excluding mail.

Table 4 : Mehrabad revenue operation (April 1989-March 1990)

(source : Kayghobadi, 1990)

Flight	Passenger(000)			Cargo/kg/000			Post/kg/000		
	Out	In	Total	Out	In	Total	Out	In	Total
Inter-national	619	595	1214	17336	20635	37971	2290	1046	3336
Domestic	1798	1854	3652	12756	10988	23564	447	602	1048
Total	2417	2449	4866	30092	31623	61535	2737	1648	4384

Table 5 : Mehrabad Airport landings and take offs (April 1989-March 1990)
(source : Kayghobadi,1990)

Flights		Jet	Others	Total
International flights	Regular	4505	---	4505
	Irregular	448	27	457
Total international flights	(regular,irregular)	4953	27	4980
Domestic flights	Regular	22963	2047	25010
	Irregular	2294	1019	3313
Total domestic flights (regular, irregular)		25257	3066	28323
Other flights	Civil flights	2301	1287	3588
	Army flights	4153	15548	19701
	Military flights	2882	9232	12114
	Foreign flights	78	506	548
Total other flights		9414	26573	35987
Grand total		36624	29666	69290
Passing (transit flights)		35379	-----	35379

During the period April 1989- March 1990 the total arrivals through the Iran Air services were estimated at 4,514,257 passengers, 30,115,510 Kg cargo and 1,138,742 Kg postal packages. The Mehrabad International Airport transported 4,865,792 passengers during the period April 1989- March 1990 (Table 4). Iran Air and Aseman transported 3,651,863 passengers on domestic flights while 1,213,929 passengers were transported by Iran Air on its international flights and other foreign flights. In the total international traffic of 1,213,929 passengers, Iran Air shared 1,019,408 while the remaining 194,522 passengers were transported by other foreign flights (Kayghobadi, 1990).

According to the Statistics Office of Mehrabad airport, 190 daily domestic, foreign, military and cargo flights (take offs and landings) were conducted between April 1989 and March 1990 (Table 5). This means that every 7.5 minutes one flight is recorded at Mehrabad Airport. Daily flights have increased in 1991, to 261 (one flight every 6 minutes) (Table 6). The Mehrabad Airport operations from 1970-1991 are presented in Figure 3.4. At the time of study Iran had 32 airports. The Mehrabad daily take offs and landings are compared with other large airports in Islamic Republic of Iran (Fig.3.5).

Table 6 : Comparison of Mehrabad Airport daily take-offs and landings with other large airports (1970-1991)
(source: Kayghobadi, 1991).

Airports	1970	1971	1972	1973	1974	1975
Abadan	49	53	47	38	44	46
Ahwaz	26	26	40	43	58	77
Bandar-Abbas	9	11	17	27	41	57
Bushehr	12	22	41	86	80	110
Isfahan	65	64	91	237	390	297
Mashhad	11	11	17	13	16	20
Mehrabad (Tehran)	*244*	*290*	*330*	*302*	*337*	*378*
Shiraz	59	61	99	217	338	350
Tabriz	5	15	31	48	61	67

Table 6 : comparison of Mehrabad Airport daily take offs and landings with other large airports (continued)

Airports	1976	1977	1978	1979	1980	1981	1982	1983
Abadan *	52	54	45	-	-	-	-	-
Ahwaz	73	70	47	23	24	12	34	14
Bakhtaran	88	127	129	92	90	37	51	37
Bandar-Abbas	51	60	54	25	24	12	34	14
Booshehr	138	146	139	34	33	25	30	36
Isfahan	140	170	170	69	80	68	64	55
Mashhad	23	61	49	21	14	89	50	47
Mehrabad (Tehran)	**401**	**426**	**320**	**215**	**179**	**164**	**195**	**214**
Shiraz	283	323	212	59	64	87	77	80
Tabriz	73	96	109	38	41	24	28	54

* Because of Iraq's war against Iran no flight from 1979.

Table 6 : comparison of Mehrabad Airport daily take offs and landings with other large airports (continued)

Airports	1984	1985	1986	1987	1988	1989	1990	1991
Ahwaz	22	19	7	5	15	24	28	33
Bakhtaran	23	18	14	15	30	32	35	46
Bandar-Abbas	38	41	44	50	53	51	50	51
Bushehr	33	39	38	44	40	40	36	41
Isfahan	63	56	15	-	-	-	-	-
Isfahan (new)	84	88	77	98	122	99	103	107
Kerman	19	17	22	27	38	49	45	44
Mashhad	39	26	45	46	40	42	56	71
Mehrabad (Tehran)	**228**	**219**	**228**	**232**	**209**	**190**	**211**	**261**
Shiraz	97	88	107	107	96	97	127	113
Tabriz	65	41	41	33	36	37	49	73
Zahedan	15	11	12	11	14	14	17	22
Ghalehmorghi (Tehran)	-	-	-	96	72	102	111	151

Mehrabad landings and take-offs 1970 -1991

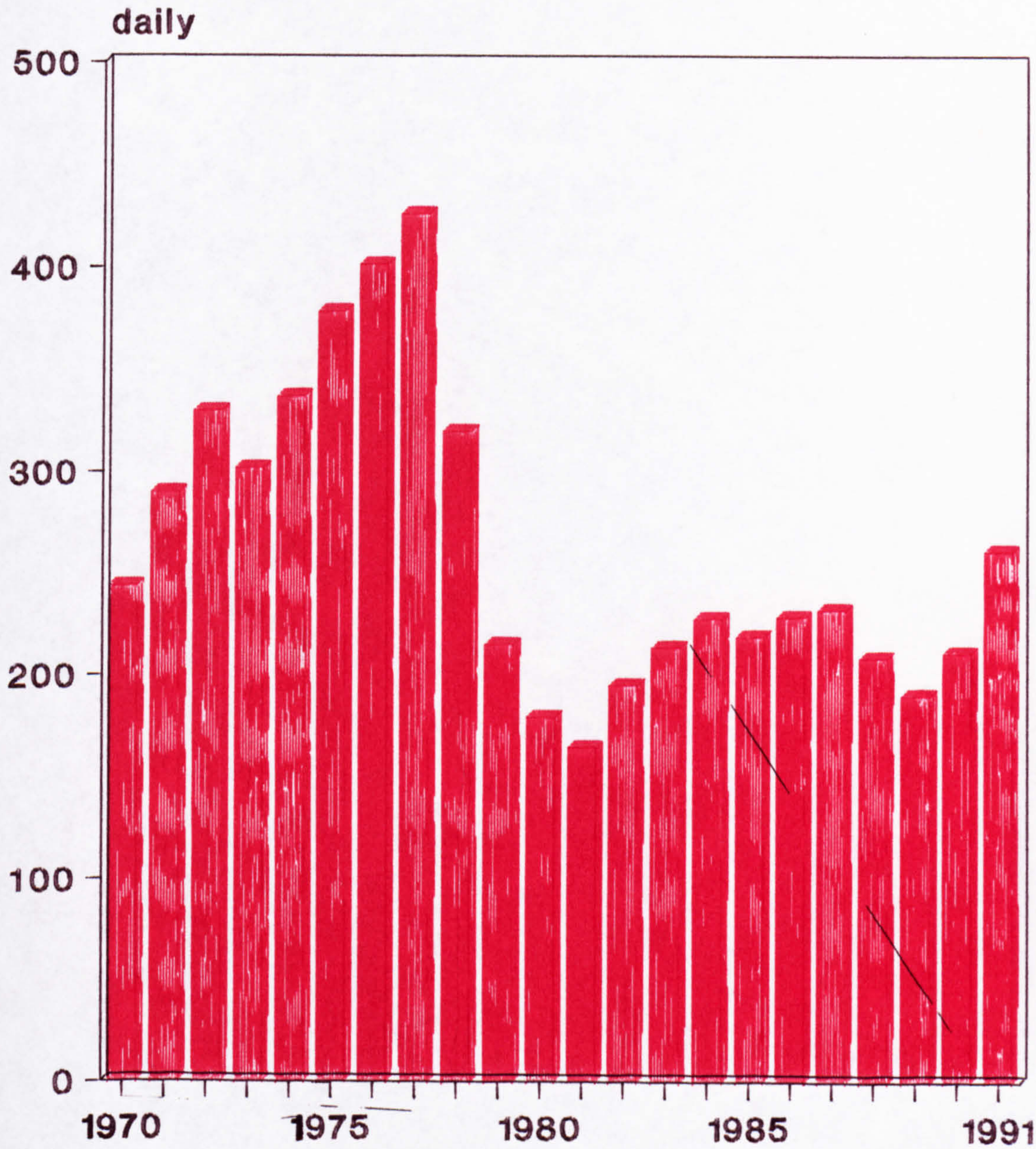

Fig 3.4. Mehrabad take-offs and landings

Airports' take offs and landings daily (1991)

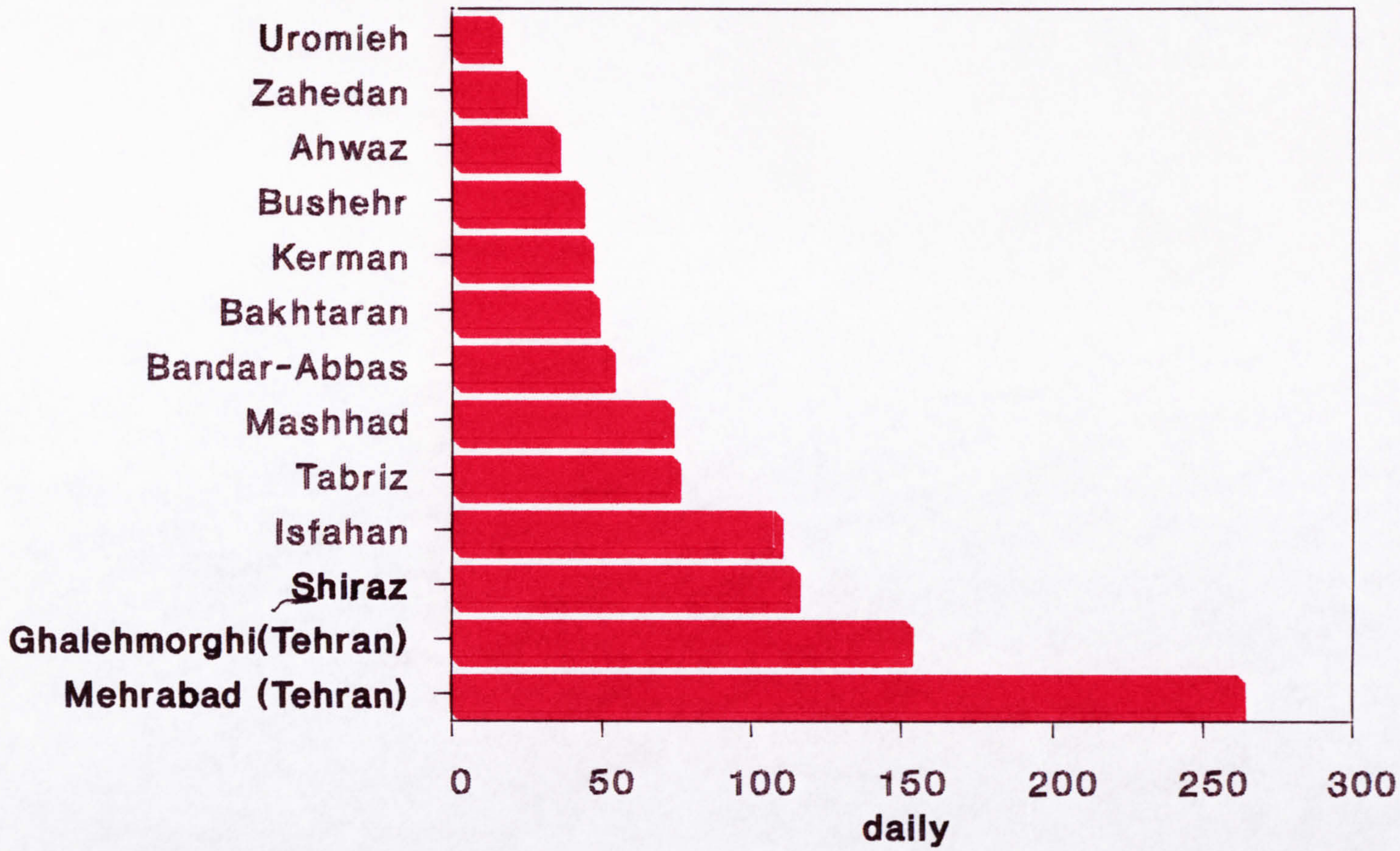

Fig 3.5. airports' daily operations

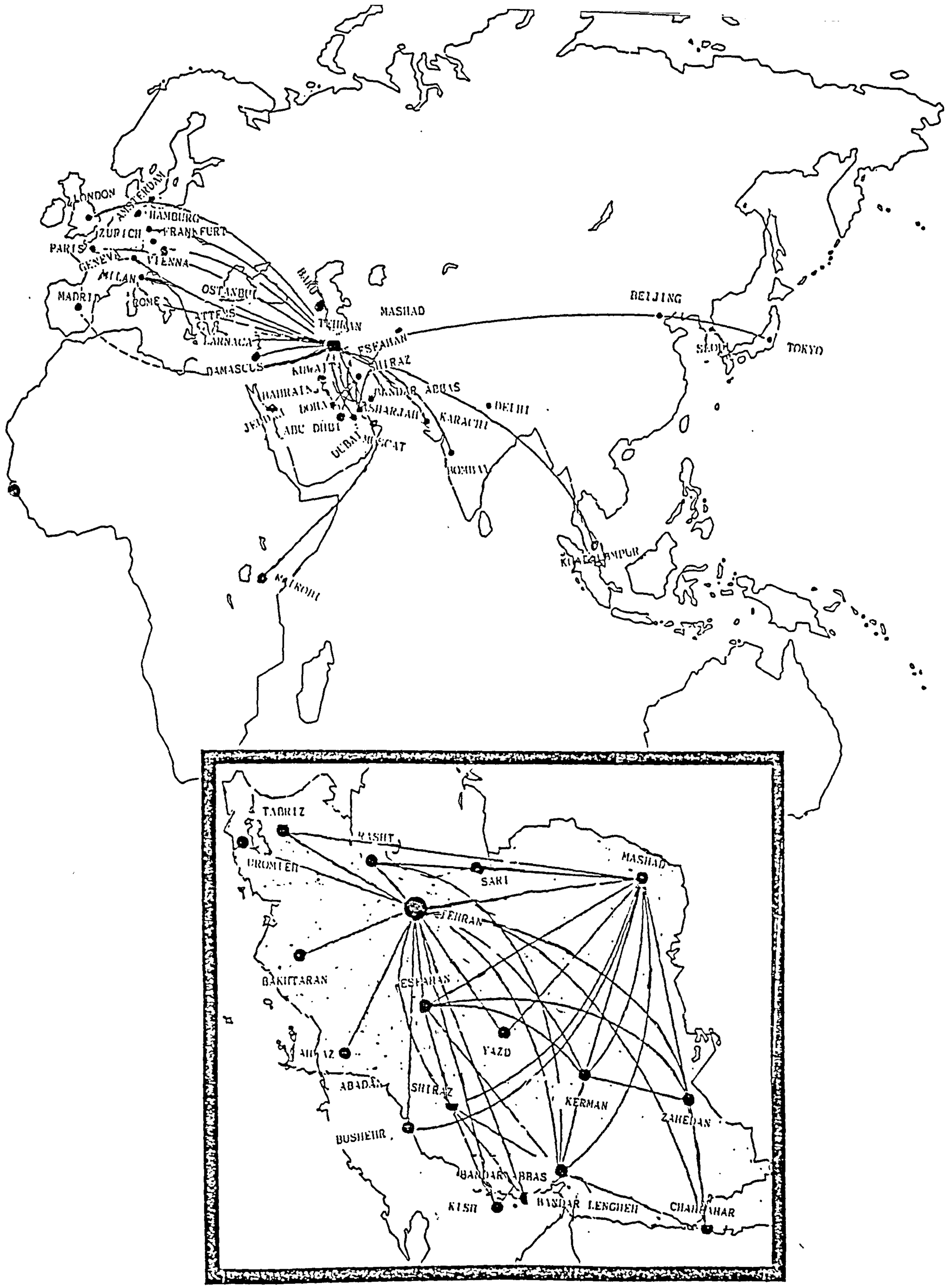

Fig. 3.6 . Iran Airways routes

CHAPTER IV NOISE AND SLEEP

CHAPTER IV

NOISE AND SLEEP

Introduction

Interference with rest or sleep is one of the major effects of noise identified by many investigators. All kinds of environmental noise can awaken people and interfere with sleep (Ahrlin and Rylander, 1979). It intrudes causing difficulties in falling asleep and awakens those who are asleep, disrupting sleep patterns (W.H.O., 1980). Sleep is a continuum . It ranges widely from a state of full awakeness to a state of deep sleep. Noise causes a shift from one stage to another (Egunjobi, 1990) and may induce shifts from deep to shallow sleep (Dejoy, 1984).

All sources of noise can disturb sleep . It leads not only to behaviourial awakening but physiological modifications which damage the quality of sleep (Bugliarello, et al., 1976). Noise can produce changes in behaviour and influence the vegetative nervous system, causing changes in heart rate, pulse amplitude and respiration (Rylander, 1978 b). So that, sleep may be disturbed without the person necessarily being awakened (Egunjobi, 1990). Therefore, disturbance to sleep is not only measured by the number of awakenings or by

difficulties in falling asleep, but it can be evaluated in terms of electro encephalo graphs (E.E.G.) reflecting the physiological effects of noise on sleep or on the quality of sleep. Therefore, noise affects both the quantity and quality of sleep. Noise may provoke sleep. This effect is especially likely for low frequency noise or other types of monotonous, repetitive sounds (Kjellberg, 1990).

Stages of sleep*

Stage 1 : At the beginning of this stage one is sleepy, but awake. The E.E.G. pattern changes from a rapid, irregular wave to a regular pattern (Alpha rhythm,9-12 Hz). This is followed by sleep stage 1, with reductions in wave amplitude and frequency. At the end of this stage, the alpha rhythm disappears to be replaced by a rapid, irregular and low-voltage wave.

Stage 2 : In this stage the pattern changes to one of bursts of waves (spindle waves) mixed with Delta waves . Delta waves are characterized by single, slow waves with high amplitude and low frequency (1.5-3.0 Hz)

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* The sleep stages are based on W.H.O.(1980), Bugliarello, et al., (1976), and Mclean and Tarnopolsky (1977).

Stage 3 and 4 : After 30-45 minutes delta waves appear in the E.E.G. (stage 3). These stages are called slow, deep or Delta sleep. The periods of Delta waves replace the spindle waves in the E.E.G. and become increasingly regular with a greater amplitude and lower frequency (0.6-1 Hz). Deepest sleep will be reached in stage 4.

Stage 5 : About 1.5 hour after stage 4, the E.E.G. pattern changes to rapid waves with weak amplitude, (stage 1) and with rapid eye movement (REM). Most dreaming will occur in this stage.

The five stages usually last from 90 to 120 minutes. During normal sleep, the sleep stages occasionally reverse. The greatest part of sleep is in stages 2 and 5 . One spends 2% of the sleep time in stage 1 ,50% in stage 2, 5% in stage 3, 15% in stage 4 and 8% awake. The time spent in deep or lighter sleep depends upon age. With increasing age, the duration of lighter sleep stages increase. Children between 18-24 month spend 50% of their sleep time in stage 5. Stage 4 will almost have disappeared in 60 year old people. All stages of sleep are needed for good physiological and mental health (W.H.O., 1980).

Effect of noise on sleep

The effects of different noises on sleep (Langdon and Buller, 1977; Vallet, et al., 1988; Ohrstrom and Rylander, 1982 and Garsia, et al., 1988) reveal that

acoustic stimuli which disturbed rest and sleep are annoying. The awakening of a sleeper will be provoked by an oscillating noise between 35-90 *dB(A)* (W.H.O., 1980). It is not only the intensity of noise which impinges upon the sleep progress but also the type of acoustic surroundings (e.g. near airport,near heavy traffic,in a noisy apartment building, near a factory, under the path of super sonic aeroplane) (Bugliarello, et al., 1976). Noise need not be loud to disturb sleep. It will probably do so if it is of cognitive significance (own name or child's cry), new or relevant to biological drives (smell of cooking when we are hungry) (W.H.O., 1980 and Loeb, 1986). The differential thresholds of awaken depend on cultural factors. A slight cry of an animal or a cracking of branches will perhaps not awaken a European or American but will awaken others as a sign of danger (Bugliarello, et al., 1976). When the extent of rest/sleep interference was varied by different noises, awakening was equal interference of all kind of noises (Ahrlin and Rylander, 1979). However, familiar sounds like ticking clocks and air conditioning sound are less likely to awaken (Pelmear, 1985).

In urban communities, environmental noise can commonly affect sleep patterns by prolonging the time take to fall asleep. Shallow sleep results in shortened total sleep time by awakening (Rylander,1978). Stress factors influence sleep only during stage 1. The shortened duration

of REM stage and extended duration of stage 1 must be assessed as sleep disturbance by traffic noise (Maschke, 1988). During nights with aeroplane noise the stages change more often than on quiet nights. The stages of light sleep lengthened to the detriment of those of deep sleep (Bugliarello, et al., 1976). Exposed to noise levels of 48-62 *dB(A)* sleep E.E.G. pattern changes and interrupt the Alpha rhythm. At 50 *dB (A)* 50% of subjects show changes of sleep stages or awakening (W.H.O., 1980). The REM stage is that which can be most easily disturbed by noise. Others point out that stages 2 and 3 or 2 and REM are easier to disturb (Bugliarello, et al., 1976). Thresholds for awakening are lower in the REM sleep stage and also E.E.G. pattern change are least likely to occur in the REM stage (W.H.O., 1980), although the awakening threshold is lowest in stage 1 and higher but equal throughout REM and stages 2 and 4 (Mclean and Tarnopolsky, 1977). The threshold for awakening is high in REM when in deep sleep (stage 4) with individuals hard to awaken in this stage (Loeb, 1986). The awakening effect of sonic booms and aircraft noise showed a similar response in sleep stages 2 and REM between subjects, and 40% of stimuli awakened them in these stages (Lukas, 1972).

The effects of traffic noise show that 63% of passing heavy vehicles caused body movement among sleepers (Ohrstrom and Rylander, 1982). Road traffic in Greater London caused sleeplessness among 30% of sleepers . About

50% of them felt that external noise was the cause. 30% of those who woke in the night, cited traffic noise as the cause of disturbance (especially if they slept with open bedroom windows). Sleep is also disturbed by pain, discomfort, anxiety and insomnia. External noise was the chief cause of sleep disturbance (Langdon and Buller, 1977).

Ahrlin and Rylander(1979) in Gothenburg (Sweden) showed all types of specific noises (trains, road traffic and aircraft) awaken people. The range varied between 13% to 22%. Higher rates of rest and sleep interference had been reported by train noise and the lowest by aircraft noise (Ahrline and Rylander, 1979). However, near to airport the aircraft noise is approximately twice as significant as other noises (Bugliarllo, et al., 1976). In Valencia (Spain) (Garsia, et al., 1988) residential areas exposed to traffic noise showed 58 % of sample population, experienced difficulty in getting to sleep and cited traffic noise as the main cause. 14% of the respondents reported waking up frequently in the night and over 23% identified traffic noise as the cause. There is a relationship between sleep with closed windows in summer, accommodation in the rear of houses and traffic noise (Garsia, et al. , 1988). Traffic noise interferes with conversation, T.V. viewing and relaxation (Langdon and Buller, 1977). The effect of traffic noise on sleep, show an increase in the number of movements during the night.

The average number of movements increased by 16% during a night with continuous noise and 22% during a night with intermittent noise. The number of body movements increased with increasing noise level and during the time periods 24.00-02.00 and 05.00 to 07.00 am . Body movement increased with the number of noisy events. There was a significant difference between sleep quality and the number of awakenings at quiet nights and nights with intermittent noise. Continuous noise was significant only for sleep quality. Poor sleep quality has observed both at night with 60 and 70 *dB(A)* however, 70 *dB(A)* caused significantly more awakenings than 60 *dB(A)* (Ohrstorm and Rylander, 1982).

Aircraft noise is an important factor which generates sleep disturbance (Blois, et al., 1980). Surveys and interviews in areas impacted by high levels of aircraft noise indicate that sleep was impaired (Loeb, 1986). Residents living under the flight paths at Heathrow Airport, had sleep disturbance, measured as a function of Noise Exposure Forecast (NEF). This identified noise as a factor to startle, keep from going to sleep, waking up and disturbing rest or relaxation of residents (Wilson,1989). Field studies of army recruits and within populations responding to 7 sonic booms per night (Rylander, et al., 1972a, 1973, according to Mclean and Tarnopolsky, 1977) revealed that 10% of recruits and 60% of civilians believed themselves to have been awakened by the booms.

2% of recruits and 56% of civilians experienced difficulty in returning to sleep. A social survey in the vicinity of London Airport for the Central Office of Information showed that 22% of people living near the airport were sometimes kept from going to sleep by the noise (Pelmear, 1985). Around Los Angeles Airport (Globus, et al., 1973 quoted Mclean and Tarnopolsky, 1977) 28 jet-fly-overs per night with a mean peak *dB(A)* of 77 had more awakening and significantly less time in REM and stages II, III and IV than 17 fly-overs at mean 57 *dB(A)*. Aircraft noise also can change sleep stages (Bugliarello, et al., 1976). In the vicinity of Toronto International and Oshawa Municipal Airports (Taylor, et al., 1981) sleep was interrupted, but the greater percentage was because of the night-time operation of cargo planes at Oshawa.

Effect of noise on sleep of children

With the increase of environmental noise due to industrial development serious consideration should be given to the effects of noise on children and future generations (Ando and Hattori, 1977). Children of 5-8 years are unaffected by noise during sleep but others show fear, awakening and are kept awake by aircraft noise (Bugliarello, et al., 1976). The afternoon effect of traffic noise on the sleep of children showed a fourfold increase in body movements, twofold increase in the time to fall asleep and decrease in total sleep time for children with high traffic

noise levels (Ohrstorm and Rylander, 1982). The sleep of babies was affected by aircraft noise but the reactions differed according to the length of time mothers stayed in noisy areas (Ando and Hattori, 1977).

After effects of sleep deprivation

Sleep deprivation is caused by noise interference with psychomotor and mental performance (Rylander, 1978b). Sleep loss affects work performance (Mikulincer, et al., 1989). After 40 hours of sleep deprivation Williams Word Memory Scores were significantly below the baseline (Rosa, et al., 1983). Subjects which had been kept awake for 64 hours had a poorer recall than others. Subjects performed significantly worse on the recovery night (Akerstedt and Gillberge, 1979). Memory performance was clearly reduced by sleep deprivation but the mechanism was not clear. After effects of jet aircraft noise on performance the next morning showed a much poorer performance than after an ordinary night's sleep. Electrical brain rhythms had slower wave components and suggested that the brain was still tired and sleepy (Pelmear, 1985). Fatigue was greater after a night with sonic booms than after a night without booms, this means that the disturbance of sleep by noise is felt the next morning (Bugliarello, et al., 1976). When sleep is lost or disrupted by whatever means the inevitable consequence is sleepiness during the waking period. However, the intense sleepiness may not lead to psychosis

but it produces transient perceptual distortions that are rarely severe enough to be called hallucinations (Stunkard and Baum, 1989). In work environments, noise might have an after effect on sleep (Bugliarello, et al., 1976). Noise exposure during the day may disturb sleep during the night (Kjellberg, 1990). Noise-induced sleep disturbance diminishes sleep quality (Griefahn and Muzet, 1978). Psychic disturbances, decrease in performance, functional disorders and morphologically defined diseases are after effects of this phenomenon. Chronic loss of sleep may impair performance and cause psychological distress. Severe disturbance of sleep may accompany most acute psychiatric illnesses (Pelmear, 1985). Disrupted sleep over long periods of time result in physiological and medical disorders like an increased tiredness, decreased social orientation and reduced work performance (Ohrstorm and Rylander, 1982). Hospital junior doctors with an average of 2 hrs sleep per night made twice as many errors and were much slower than after a night of 7 hours sleep. They felt depressed, irritable and lacking in confidence (Pelmear, 1985). Relatively significant psychological effects of noise occur if subjects are totally deprived of sleep or of certain sleep stages for several consecutive nights (Lukas, 1972). The discharge of human growth hormones in the blood appear to diminish if the deep sleep phase is reduced (Bugliarello, et al., 1976). There is a statistically significant correlation between self estimates of sleep quality with annoyance (Loeb, 1986).

Consequently sleep disturbance is a major environmental noise effect (W.H.O., 1980; Alexandre, 1974).

Results and Discussion

Sleep disturbance due to aircraft noise is evaluated by behavioral responses . A total of eight questions were asked directly about sleep disturbance (difficulty getting to sleep and awakening in the night) or some questions related to it (such as where is the bedroom situated or whether windows are closed or open). Some 21% of respondents reported considerable difficulty in getting to sleep (Fig. 4.1) and mostly cited the aircraft noise as the main cause (Fig.4.2). Some 38% of respondents reported waking in the night (Fig.4.1) and most of them also reported aircraft noise as the main reason (Fig.4.3). 41% of respondents who mentioned that they slept with windows closed in summer, stated noise in general as the main reason (Fig.4.4). 60.5% of people who responded sleep at the front of their dwelling and 39.5% sleep at rear. The women were awakened less frequently by aircraft noise than were the men (about 41% versus 53% respectively). In the case of children, from 31 % of parents who stated that their children lose sleep, mostly reported aircraft was the main cause.

To highlight relationship between sleep disturbances due to aircraft noise and individual aspects like marital

aircraft noise problems

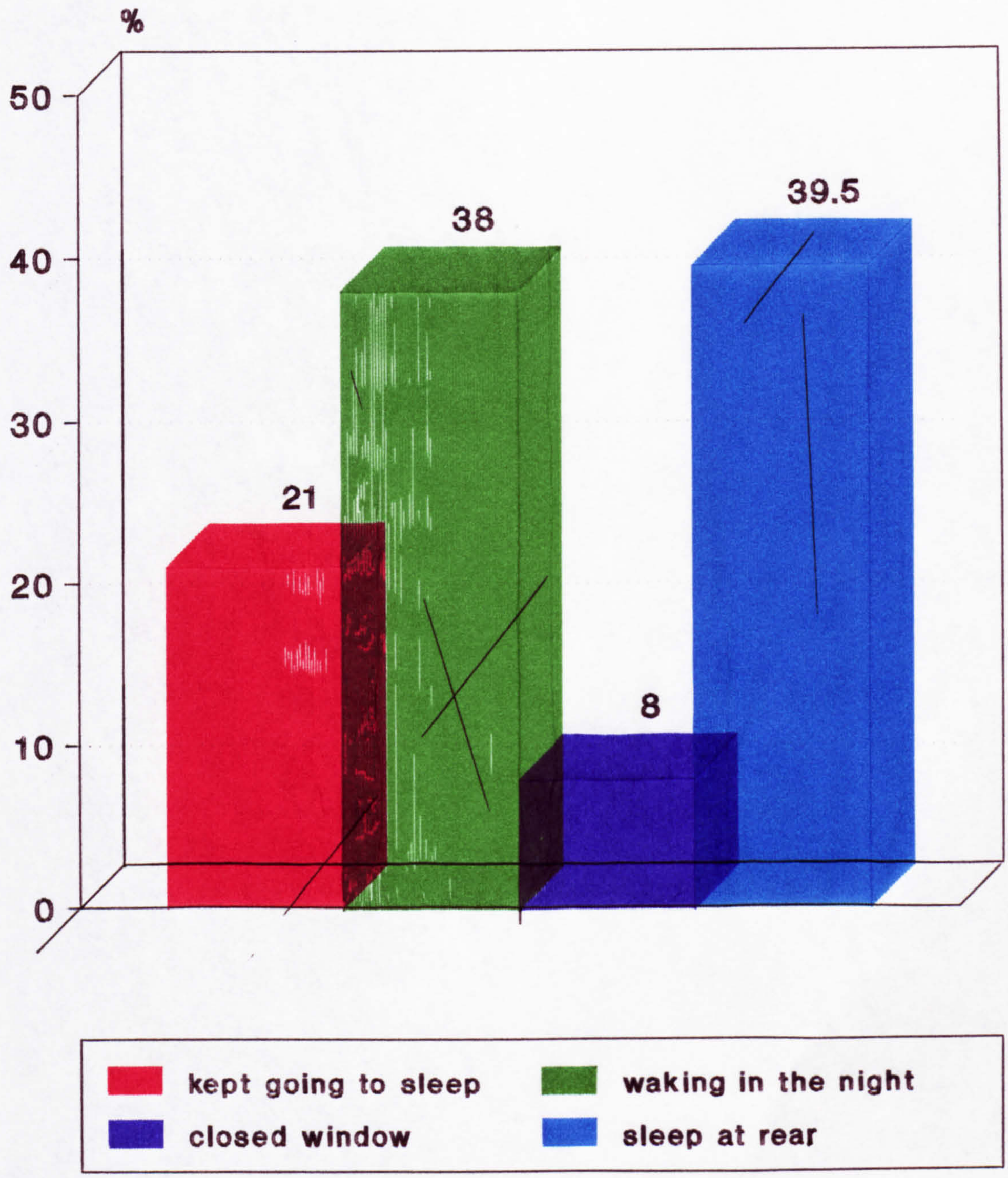

Fig. 4.1 : sleep disturbances

Reasons for difficulties in getting to sleep

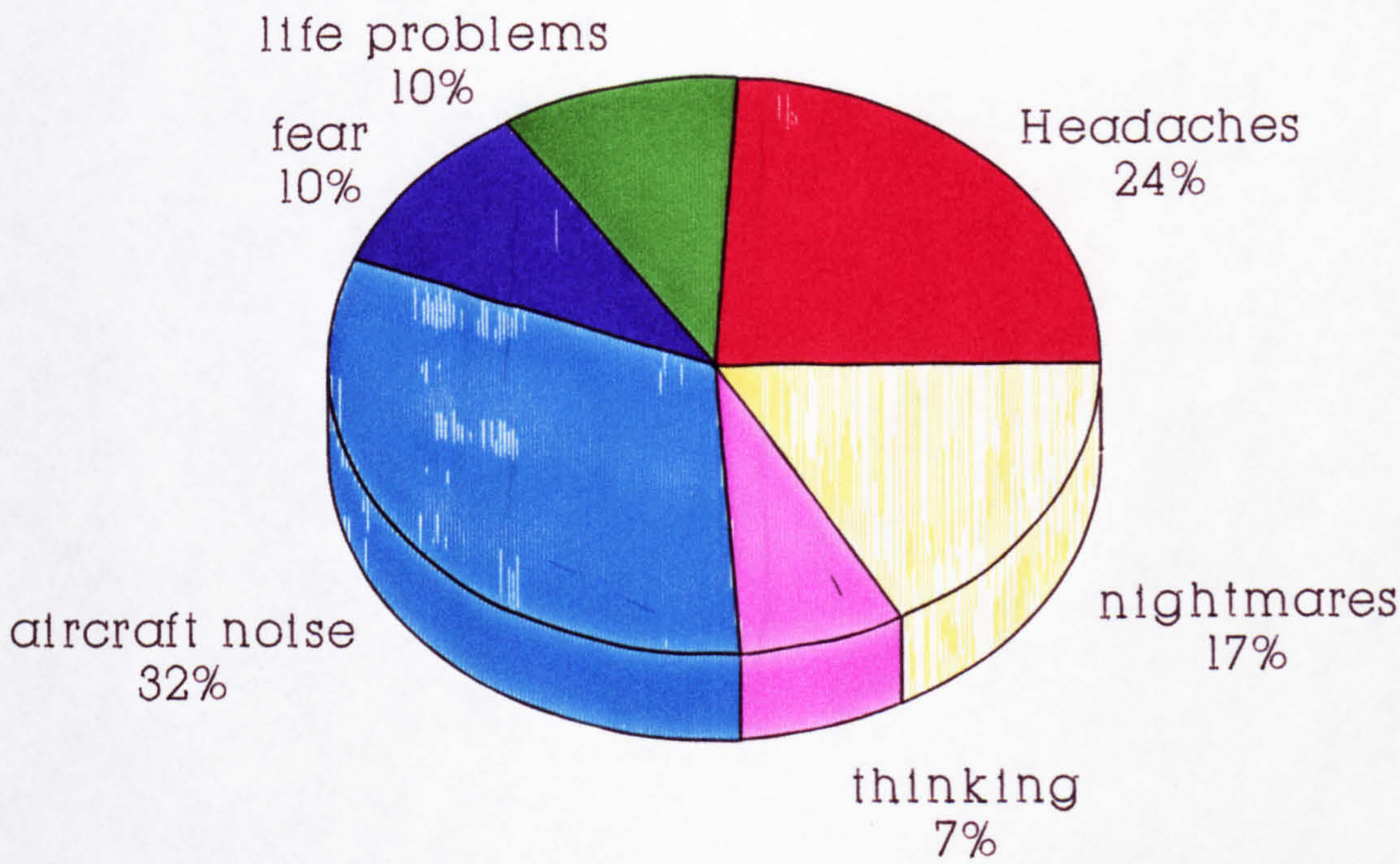

Fig.4.2.

main reasons for sleep disturbance

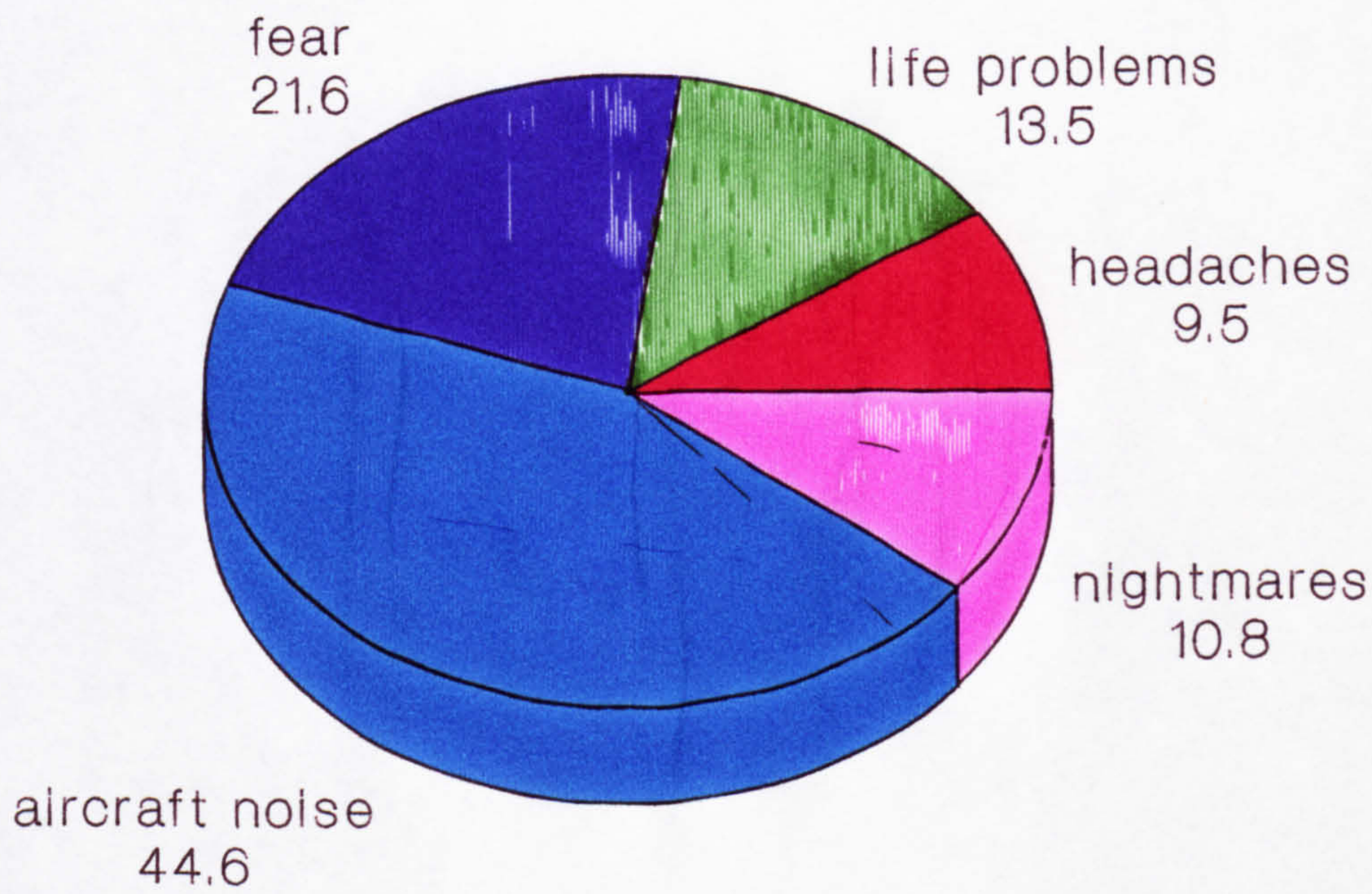

Fig.4-3 : reasons for waking up

reasons for sleep with windows closed in summer

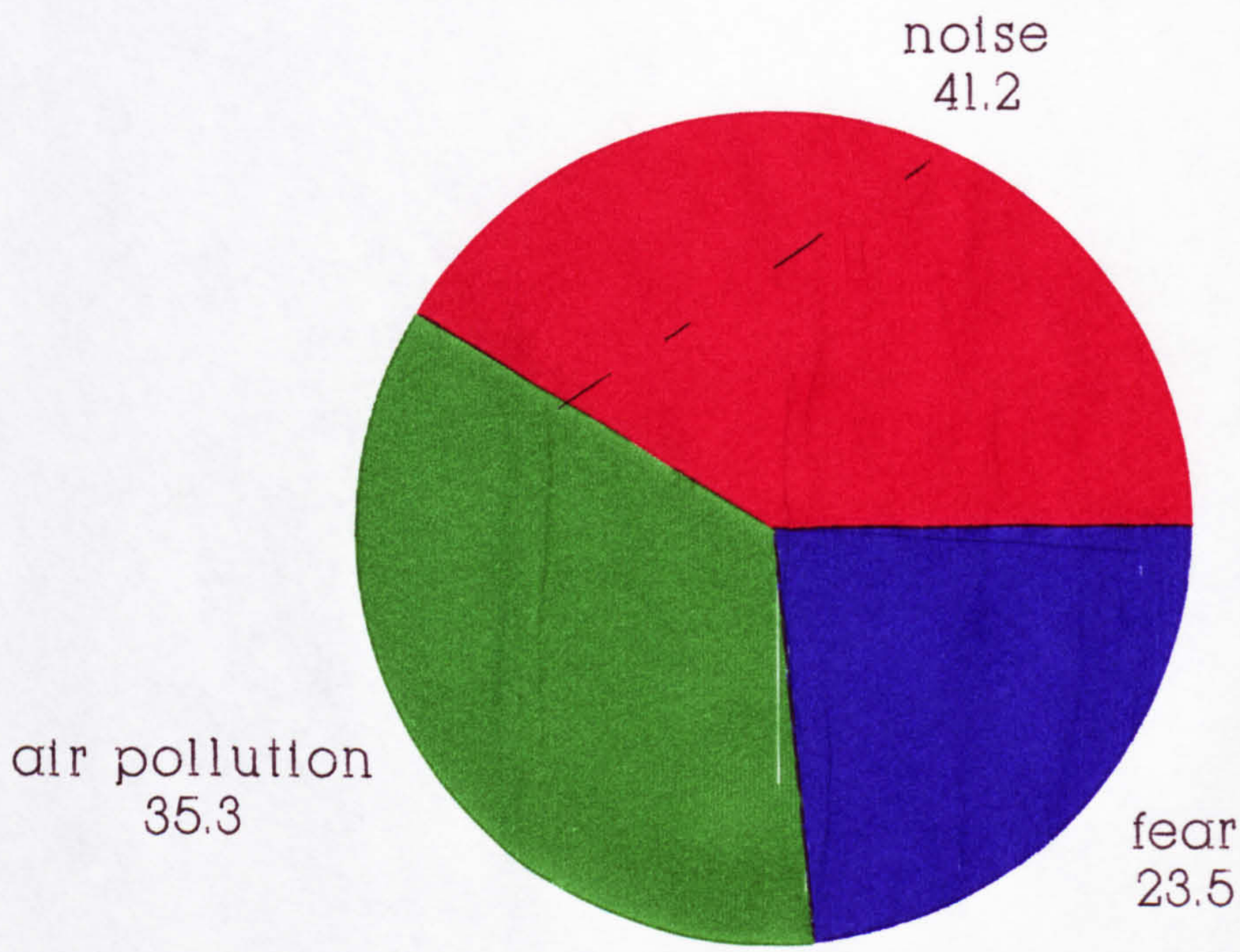

Fig. 4.4.

status, education level and occupation, percentages of respondents were computed. The results indicate that better educated people reported more sleep disturbance (Fig.4.5) and the percentage of awakening during night due to aircraft noise relates to occupational status (Fig.4.6). 38% of single people awaken during night and 19% have difficulty in getting to sleep due to aircraft noise . The proportion of married people are 33 and 13%.

Sleep disturbance is more related to aircraft noise level than other problems. With increasing levels of aircraft noise , the percentage of sleep disturbance considerably increases (Table 7).

Aircraft noise not only causes behavioral sleep disturbance it can diminish the quality of sleep . This means that the sleep of people, is disturbed though they are not awakened. This is emphasised if the experimental observations are combined with those of other authors. In the present study, sleep disturbance was evaluated as a self-reported behavioral problem. It does not include other aspects such as changes in sleep stages or quality of sleep where sleep will be disrupted without the person necessarily being awake (Egunjobi,1990). Effects of sleep loss affect mental (Akerstedt and Gillberge, 1979), work performance (Mikulincer et al., 1989) and sleepiness during waking periods (Stunkard and Baum, 1989).

sleep disturbances due to aircraft noise

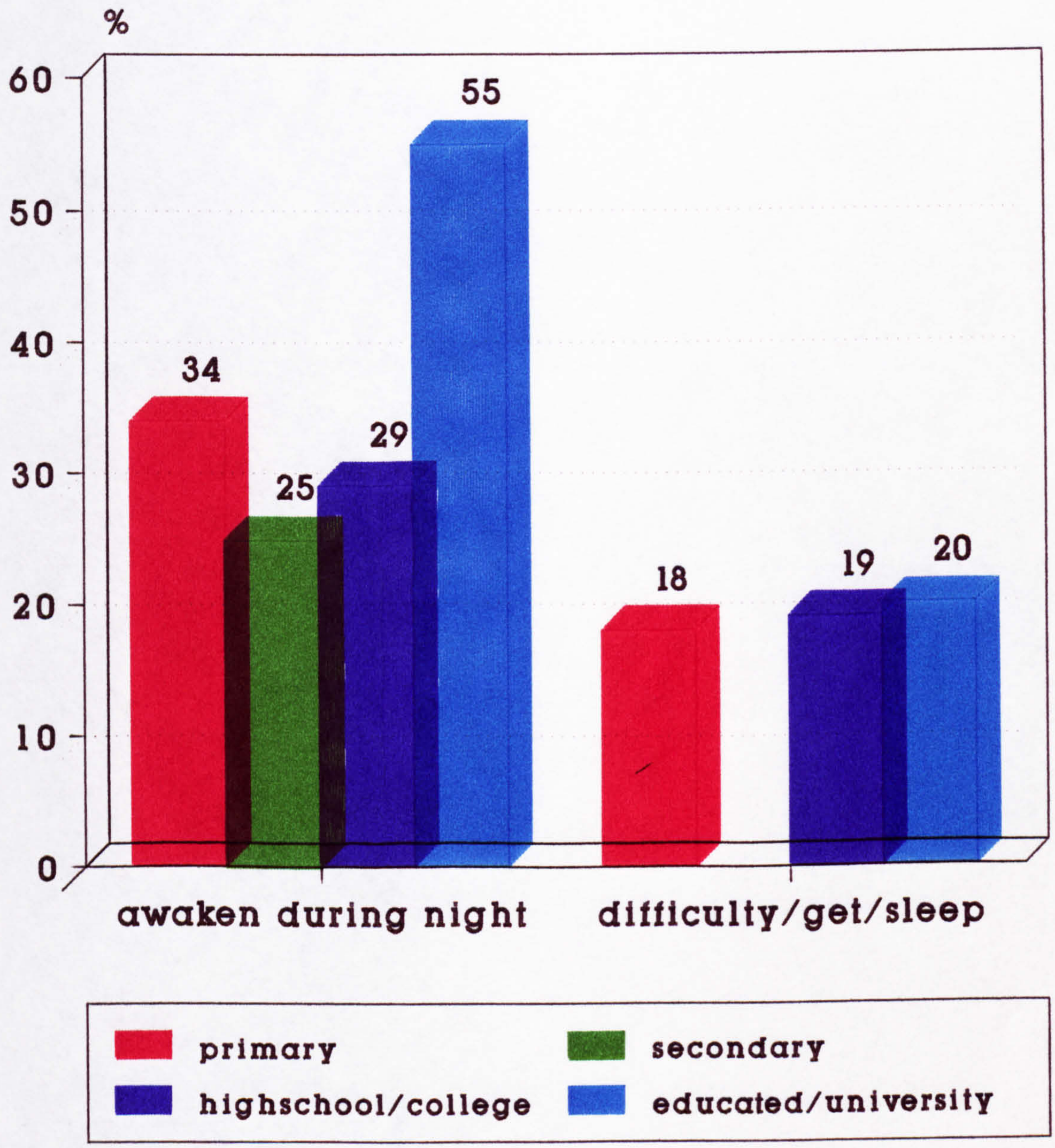

Fig. 4.5 :E level and sleep disturbance

sleep disturbance due to aircraft noise

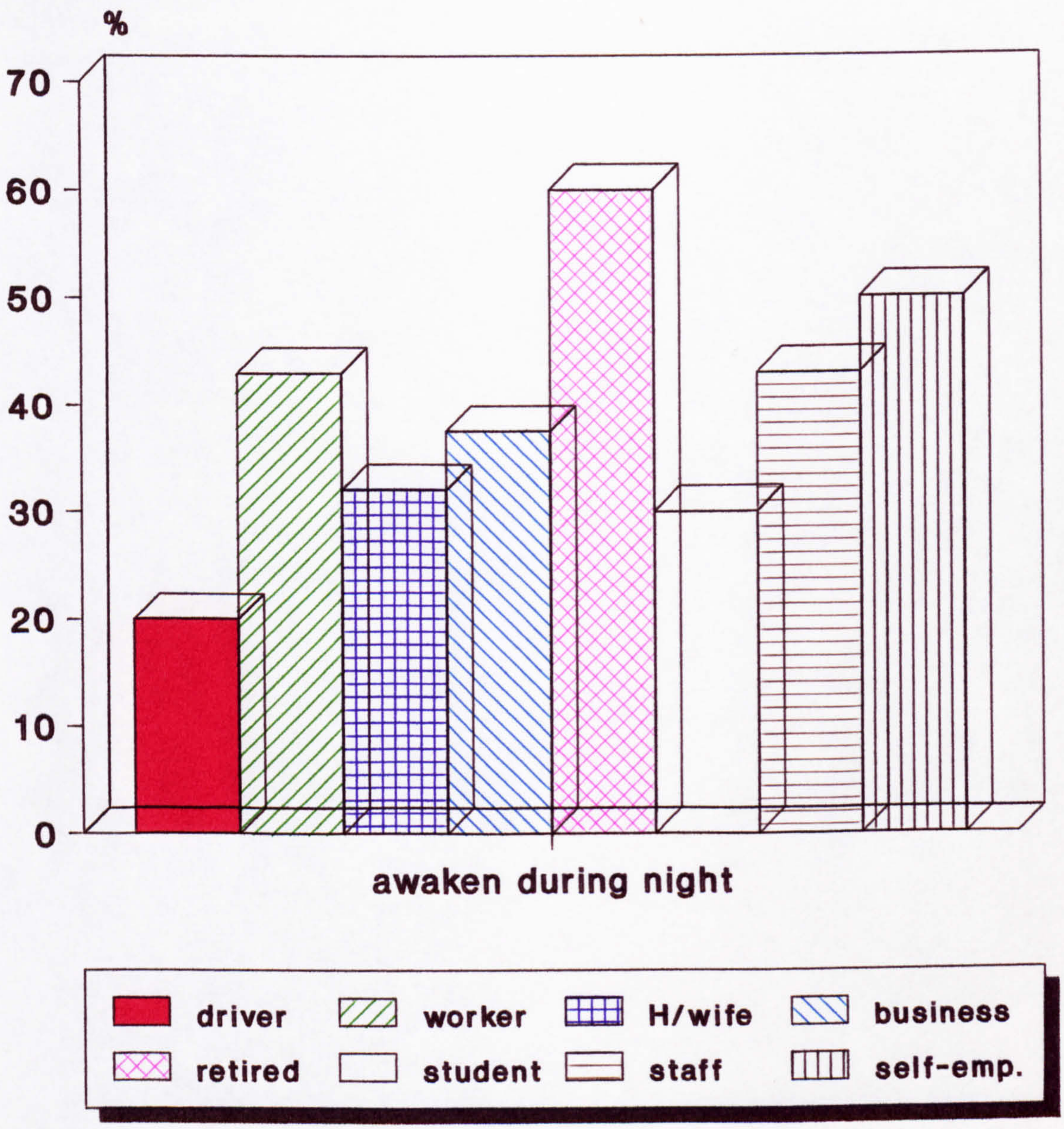

Fig.4.6 : occupation/sleep disturbance

Table 7 : Percentages of disturbances in different areas

Disturbances	NNI=46 (area 1)	NNI=47 (area 2)	NNI=53 (area 3)
Fear of crashing	67	69	69
Startling	21	22	34
Sleep	19	49	62
Audibility of radio and T.V.	26	43	48
T.V. picture flicker	40	57	48
Conversation interference	26	36	40
House vibration	49	52	47
Difficulty getting to sleep	15	4	26
Awakened during night	7	26	70

CHAPTER V NOISE, HEARING AND COMMUNICATION INTERFERENCE

CHAPTER V

NOISE, HEARING AND COMMUNICATION INTERFERENCE

Ear structure

The ear has outer, middle and inner divisions (Fig 5.1). The Outer Ear is the auricle or pinna, which collects and funnels sound into the auditory canal or (meatus). The canal is about 2.5 cm in length and it directs sound pressure pulses on the eardrum (tympanic membrane). The middle ear includes the eardrum , ossicles, muscles, the mastoid space, bones and the eustachian tube. The bones include the hammer (malleus), the anvil (incus) and the stirrup (stapes). They interconnect and transmit vibrations from the eardrum to the oval window. The eustachian tube connects the middle ear to the back of the throat (nasal cavity or nasopharynx), allowing pressure balance on both sides of the eardrum as atomospheric pressure fluctuates. It is approximately 37 mm long. The tube is normally closed but opens whenever an individual swallows. If the tubes are closed, the pressure differential may be sufficient to rupture the eardrum. The inner ear consist of two separate system, the semi-circular canals as the organ of balance and cochlea (Bruel and Kjaer Ltd, 1984). The cochlea is the hearing organ , a tube coiled around a central stem, is encased in bone. The tube is divided longitudinally into three fluid-filled canals (Fig. 5.2). Two of these,

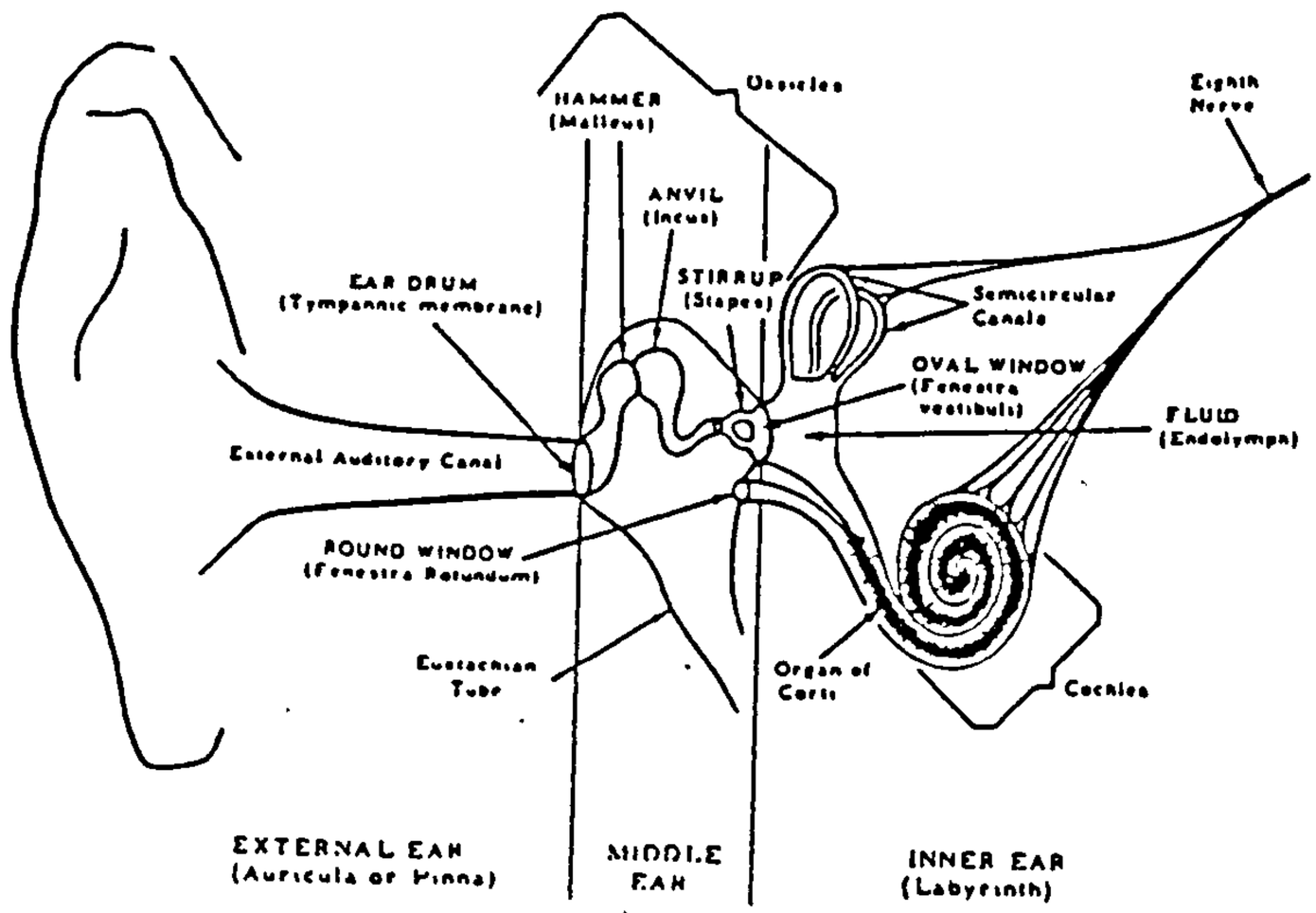

Fig 5.1. Structure of the ear (source : King and Magid,1979)

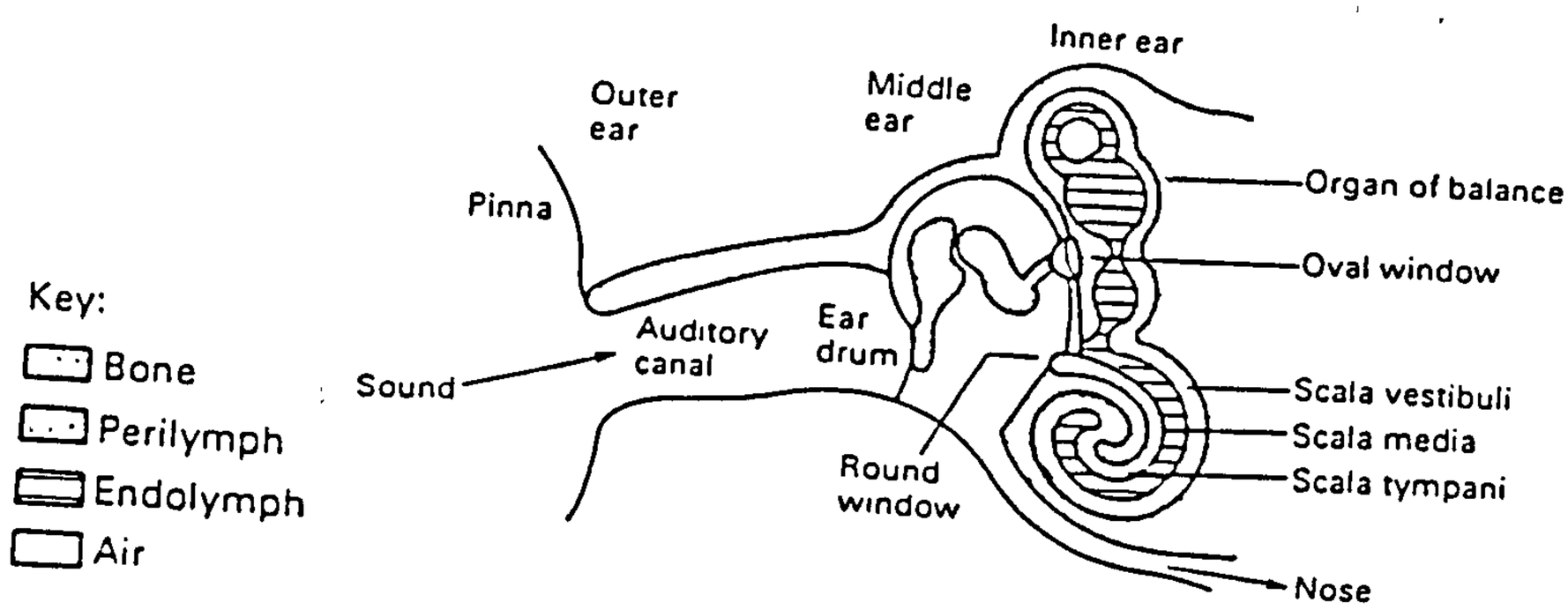

Fig. 5.2. Simplified diagram of the ear.

(source : Malerbi, 1989)

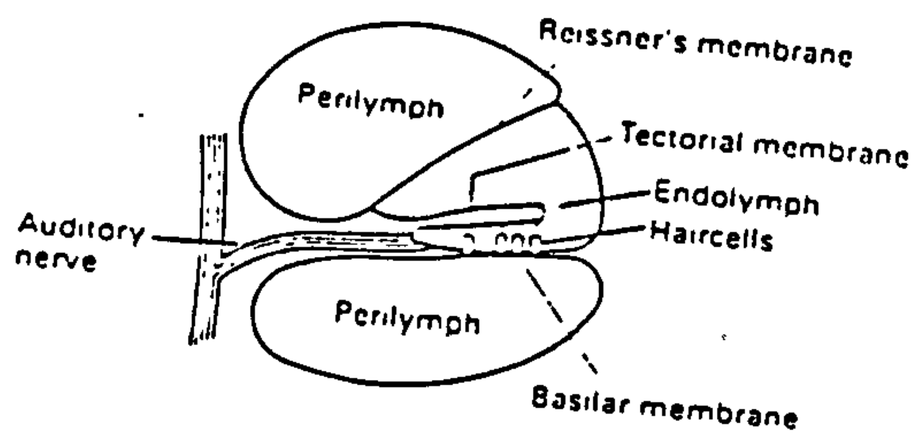

Fig. 5.3. Cross-sectional view of the cochlea showing organ of Corti (source : Malerbi, 1989)

the scala vestibuli and the scala tympani are connected at the apex by a narrow passage, the Helicotrema. They contain liquid perilymph (Fig. 5.3). Between them is the scala media with a triangular cross-section. It contains the organ of corti, comprising about 24000 special cells, with hair-like processes called stereocilia embedded at the upper and in the over hanging tectorial membranes. The hair cells are connected to the nerve endings of the auditory nerve and lie along the basilar membrane which responds to , and transmits vibrations from the perilymph in the scala tympani, to the endolymph, thus exciting the nerve endings via the movement of the stereocilia. There are two rows of hair cells, the outer row is three or four cells deep. The inner row is a single line of cells. An enclosed channel between the two rows of hair cells (Tunnel of Corti), is filled with cortilymph, whose chemical composition is more like Perilymph than Endolymph.

Threshold of Hearing

The ear is capable of hearing a wide scale of loudness from the softest sound (the Threshold of Hearing) to the intense and distressing roar of a jet aircraft (Cook, 1989).

Threshold of Hearing	$1 = 10^{1} = 0$ decibels
speech	$100000 = 10^{5} = 50$ dB
typing	$10000000 = 10^{7} = 70$ dB
Jet aircraft	$10000000000000 = 10^{13} = 130$ dB

The last sound is ten million times as loud as the first.

The sound wave's frequency expresses the number of vibrations per second in units of Hertz (Hz) (Bruel and Kjaer, 1986). Sound exists over a very wide frequency range. Normal hearing is the ability to detect sounds in the audio frequency range (W.H.O., 1980). The Human ears are sensitive to sound between approximately 20-20000 Hz. Many mammals hear higher frequency sounds (e.g. monkey, rats, dogs and cats up to 40000 to 50000, bats up to 100000 Hz) (Cheremisinoff and Cheremisinoff, 1977). Sound with frequencies under 20 Hz is normally inaudible for man and is called infrasound. Sound over 20000 Hz is also normally inaudible and is called ultra sound (Bruel and Kjaer Ltd, 1986).

In the normal auditory process, sound vibrations in the air enter the ear through the outer canal which varies in diameter and transmits sound to the a cone shaped eardrum with an included angle of about 120 degrees inside the inner ear. The eardrum vibrates under the influence of incident sound wave transmitted by the bones of the middle ear. These reduce the amplitude but increase the force upon inner windows which transmit liquid borne pressure waves within the circular canals and cochlea. The liquid pressure fluctuations within the Cochlea excite the hair cells which are connected into the auditory nerve. In the brain the waves are perceived as sound or noise (Mulholland and

Attenborough,1981 ; W.H.O.,1980). The human ear therefore converts vibrational energy though mechanical and hydraulic linkages into electro-chemical nerve impulses transmitted to the brain via the auditory nerve whence the signal is processed, codified and ultimately perceived (Fraser, 1989).

Hearing loss

Abnormal hearing loss (deafness) is a change in threshold of 40 dB or more in speech communication divided into conductive and nerval (Fraser, 1989) or conductive and perceptive (Malerbi, 1989).

1- Conductive hearing loss arises from disorders in the outer or middle ear (Malerbi, 1989) due to :

- impacted wax, or a foreign body in the ear canal, reducing the amplitude of sound entering the ear by a sound barrier.
- eardrum ruptured by an explosion or a blow on the head, or perforated by disease, such as measles.
-eustachian tube blockage due to discharge or swelling, so that middle ear does not adjust to atmospheric pressure. The eardrum will be under tension, and will not respond efficiently to sound.
- ossicles dislocated by blast from an explosion, or a blow on the head.

conductive deafness occurs through disease or progressive degeneration and injury to the conductive system. Otosclerosis, is an excessive over growth of bone blocking the round and oval windows (Fraser, 1989).

2-Perceptive (Sensorineural) deafness : Is due to damage to the inner ear, involves the hair cells, the auditory nerve or the hearing centre of the brain (Malerbi, 1989).

- Congenital deafness: Is caused by diseases such as rubella and influenza or medication taken by the mother during early pregnancy.

-Accidents at birth : Injury and disease of the newborn or drugs can cause perceptive deafness.

-Ototoxicity : is a side effect of some commonly used drugs either on hair cells, or the auditory nerve. Antibiotics, artirheamatic and anticancer drugs, some diuretics , also quinine, nicotine , alcohol, contraceptive pills, eraldin and aspirin are to be avoided especially if taken regularly for long periods.

- Nerve deafness : the worst condition is where the auditory nerve is disrupted or destroyed by disease. The person becomes " Stone Deaf". Nerve deafness is an irreversible, complete loss of hearing.

Presbycusis and Sociocusis

Presbycusis or progressive deafness occurs as the hair cells die off. It is due partly to age and experienced

high noise levels (Mulholland and Attenborough, 1981). Hearing loss caused by noise exposure is sociocusis, (Bugliarello, et al. ,1976).

Noise induced hearing loss

The ear can be damaged by noise (Mulholland and Attenborough, 1981; Tobias and schubert, 1981; Bruel and Kjaer, 1986) causing physical injuries to the eardrum or the middle ear . Large shock waves break the bones of the middle ear causing instantaneous deafness. This can be repaired by surgery and prostheses (Mulholland and Attenborough, 1981). When sound exposures are of extremely high intensity as with explosions, firing of guns, or jet engines injury results due to destruction of the eardrum, the middle ear and/or parts of the inner ear and destruction of the hair cells (Tobias and Schubert, 1981). Intense noise or long stays in a noisy environment can lead to permanent reduction of hearing sensitivity due to damage to the sensory organs of the inner ear which can never be repaired. A short period of high intensity sound starts to deteriorate and break the hair cells. The number of hair cells damaged or destroyed increases with increasing intensity and duration of noise . Progressive loss of hair cells is accompanied by progressive loss of hearing (W.H.O., 1980). In general, nerve cells within the human body do not regenerate , so that once a hair cell has been

damaged it is totally lost.

The biochemical theory postulated that the habitual noise exposure slowly induces changes in the biochemical states of the inner ear, subsequently and indirectly destroying the hair cells (Stream, 1980). Hair cell metabolism is increased by high exposures to noise and results first in nonphysiological consumption of enzymes. This leads to associated metabolic disorders and finally to permanent damage (Tobias and Schubert, 1981).

The ear's defence mechanism against noise, the acoustic reflex, has vital weak points. Muscles within the middle ear become fatigued and slow if overused. A person working in a noisy environment with high noise levels will gradually lose their strength and thus more noise will reach the inner ear (Cheremisinoff and Cheremisinoff, 1977). The ear is protected by mechanisms which are activated by high sound level like, reduction of sound transmission into the inner ear by the stapedius reflex. Decrease of the basilar membrane by reducing the active motion of the stereocilia of the outer hair cells is mediated by efferent nerve fibres (Ising, et al., 1990).

Noise- induced Temporary Threshold Shift

A measurable loss in hearing sensitivity may be recovered by returning to a quiet environment. This

phenomenon is measured as a shift in Audio Metric Threshold as the Noise-Induced Temporary Threshold Shift (TTS) or auditory fatigue (W.H.O., 1980). After spending a short period in intense noise and then moving to a quieter area, low sounds are temporarily not heard. The extent of the shift depends upon the period of exposure, the intensity of the noise and the type of continuous or impulsive exposure (Fraser, 1989). Exposure can be as much as 48 hours or more if overtime is normally worked. Full recovery of hearing may not be achieved until the week end and then only if nonworking periods are spent in quiet pursuits (Malerbi, 1989). The recovery of Temporary Threshold Shift is faster in the low and speech frequencies (500, 1000, 2000 Hz) . These part recover to normal levels 30 minutes after exposure while frequencies higher than 3 Khz remain below baseline values for up to 1 hour (Wu, 1989). The Temporary Threshold Shift will be further shifted from base level if exposed again to the noise before the TTS recovers. As the process is repeated it can cause permanent threshold shift with no more recovery (Wu, 1989).

Incomplete recovery of Temporary Threshold Shift(TTS) before further noise exposure causes residual threshold shift to accumulated and become permanent. The most rapid increase occurs during the first 10 years of continuous exposure (Malerbi, 1989). The critical level of noise in 75 *dB(A)* above which hearing will be damaged if the exposure is too long (Wu, 1989). Levels between 85 to 90

and above for 8 hours a day over a period of 20 years cause permanent deafness (Ising, et al. , 1990). Environmental Protection Agency has concluded that there is a risk of permanent hearing damage after 40 years of exposure to steady daily noise levels of 75 *dB(A)* during eight hours a day to 84 *dB(A)* for one hour a day.

Busy streets, highways and airports have noise levels higher than 75 *dB(A)* (Alexander and Barde, 1981). Airports in Germany showed maximal flight noise levels considerably exceeded 115 *dB(A)* . Ear symptoms (tinnitus lasting more than one hour and permanent hearing threshold shifts of > 30 dB) were higher (Ising, et al. , 1990). A New York City Airport noise measurements also showed a positive but not statistically significant association between exposed to aircraft noise and the risk of high frequency hearing loss among school-age children(Green, et al ., 1982). Heathrow Airport (London) also showed no significant different between experimental and control group among school-age children (Fisch, 1981).

Noise damage to the ear is associated with prolonged exposure to noise levels between 85 and 90 *dB(A)* and intense sounds can rupture the tympanic membrane or damage the middle and inner ear (W.H.O., 1980). Continuous noise above 85 *dB(A)* causes slow, insidious and progressive damage which is seldom noticed by the recipients until it is far too late (Mulholland and Attenborough, 1981). Higher

noise levels (over 90 dB) due to momentary explosions or progressive exposure cause deafness (King and Magid, 1979). Continuous loud noise is more dangerous than a momentary bang. Sudden loud impulse noises are likely to cause temporary conductive hearing losses, but continuous loud noises cause irreversible sensorieural hearing losses (Ellis, 1983).

The Ear-Nose and Throat (ENT) unit of the Lagos University Teaching Hospital in Nigeria warned (1984) that Nigerians might lose their hearing in the next few decades as a result of continuous exposure to urban noise (Egunjobi,1990). Interrupted noise is less harmful than continuous steady-state noise at same level (W.H.O., 1980) but considerable hearing handicap at different levels may depend on respective noise situations (Tobias and Schulbert, 1981).

Noise and communication

The effects of noise on speech interference is the most well-documented of all "extra auditory" problems (Stream, 1980). Loud noise produces deafness and interferes with speech communication (Smith, 1989). When speaking, background noise of 45-60 dB (A) is moderately disturbing and at 65 dB (A) one has to shout to be heard. Interference affects person-to-person or group conversations, television or radio listening, and disrupts

formal classroom teacher-student interaction (Egunjobi, 1990).

Hearing damage inevitably disrupts speech communication. Speech intelligibility in noisy areas is reduced and masking of communication may explain how performance and behaviour cause annoyance and mental health effects of noise (Tobias and Schubert, 1981; Dejoy,1984).

In Gotenburg (Sweden) exposure to train, aircraft and road traffic noise interfered with speech. Most complaints belonged to people who were exposed to train noise while the number was minimum from those exposed to road traffic noise (Ahrlin and Rylander, 1979). It is also suspected that the noise of every day life like doorbells, telephones or electronic signals is having a limiting effect on normal hearing and impairing speech communication. With loss in hearing, speech communication may be severely affected (W.H.O., 1980). Cumulative damage due to noise, additional exposure results in potential disruption of the hearing organ that will not be directly perceptible hearing impairment (Tobias and Schubert, 1981).

After effects of hearing loss and communication interference

A syndrome associated with a temporary loss of hearing observed by Bacon (1927) consists of a ringing in

the ears and temporary or long-lasting changes in sensitivity following exposure to loud noise (Loeb , 1986).

A significant consequence of communication interference and deafness in occupational situations is the failure of workers to hear warning signals or shouts which may lead to injury or death by accident (Dejoy ,1984 ; W.H.O., 1980). The sound of clinking metal components in a plant manufacturing air and oil filters was a warning sound perceived on 18% fewer occasions by workers with a substantial hearing loss than by these with normal hearing or only a mild hearing loss (Wilkins and Acton, 1982). Noise may mask warning signals or necessitate the use of hearing protection which interferes with the perception of auditory information.

Speaking under noisy conditions may damage vocal cords, cause mental problems (encumbrance of nerves), initiate unpleasant changes to the whole verbal behaviour of adults and possibly damage children as "Dysphonie" which popularly known as Walkman Syndrome (Gosy, 1988). Laryngopathies , laryngitis, vocal cord polyps and nodules were all found in people who work in noisy environments (Smith, 1991).

Children appear to be particularly susceptible to communication interference by noise. They require the clear perception and repetition of speech sounds during a

learning period. The academic performance and cognitive development of school-age children living and attending school in noise-impacted neighbourhoods results in impaired language and reading skills (Dejoy, 1984). Children are more sensitive to noise than adults and levels of noise which do not interfere with adults communication may interfere significantly with the perception of speech by children as well as with the acquisition of speech, language, and language-related skills (Mills, 1975). Speech interference due to aircraft noise has been investigated by Crook and Longdon (1974) in schools near London airport. The peak level of 70 dB(A) interfered with teachers' speech and caused tiredness and headaches. Pupils became noisier and less inclined to work. It is suggested that school teachers suffer considerable hardship and inconvenience from aircraft noise, principally because of the frequent interruption when speaking. Teachers were very reluctant to stop talking because of losing their concentration and their listeners' attention. At Kai Tak International Airport (Hong Kong) the effect of aircraft noise on teachers was the most severe disruption experienced by teachers on speech and teaching (Ko, 1979). The loss of concentration by pupils may be the reason for this problem and the effect of aircraft noise on the responses and activities of teachers are not as serious as the interference on speech and teaching (Ko, 1979). After hearing and speech disruption, the psychological after effects are the most important.

Psychological after effects of hearing loss

Perhaps the most devastating effect of hearing loss is a social one, the inability to take part in meetings and conversations (Bugliarello, et al., 1976) . There is a significant relationship between psychological disturbance and acquired deafness (Thomas and Gilhome Herbst, 1980). 28 % of hearing impaired respondents reported other health problems over and above the hearing loss. Psychological disturbance was over three times higher than in the general population and hearing impaired people feel significantly more lonely than normal hearing adults. The major outcome of this study may be that the feeling of loneliness itself is caused by social and emotional isolation. Consequently, this phenomenon may produce a chain of psychological problems from hearing loss and discomfort to social isolation (Stirling, 1986).

Deafness is accompanied by considerable stress (Thomas and Herbst , 1980). Deaf persons feel lonely, even at home, unhappy at work and sometimes appear to have a significantly depressed self-image. In other words, deafness changes life style and increases isolation (Mclean and Tarnopolsky, 1977). Wilson (1989) has pointed to Helen Keller's sentence " blindness cuts people off from things, deafness cuts people off from people". Hearing loss may result in distortion of sound and garbled understanding of words. This communication problem may ,in turn, result

in social isolation when friends and business associates find conversation difficult with the hearing-impaired person. Partial deafness interferes with participation in meetings and other normal social activities such as radio and television listening. Two large scale surveys in a mental hospitals (McCoy and Plotkin, 1967; Jeter, 1976 quoted Clark, 1984) showed that hearing loss in patients was four times the expected rate found in the general population. Earlier findings (Kay and Roth, 1961) had also established a relationship between psychiatric disorders and deafness. They investigated 100 patients admitted to English and Swedish hospitals with a diagnosis of paraphernia. They found that paraphernic patients show a higher prevalance of hearing loss (Clark, 1984). In English sample 40% of these patients were deaf compared with about 20% of effective controls, whilst in Sweden samples were 15 % and 7% respectively (Mclean and Tarnopolsky, 1977). Cooper, et al., (1974) had shown that deaf paraphernics had higher percentages of pre-morbid personality characteristics. Paraphernia is a psychiatric disorder which resembles Schizophrenia. It is often associated with delusions and hallucinations. The misperception of speech and lack of auditory stimulation may lie behind the development of such delusions and hallucination (Clark, 1984). Higher prevalence of psychiatric illnesses also reported among deaf in comparison with control group (Mehapatra, 1974). There is no association with the duration of deafness nor with the use of hearing aids, it

correlates with living alone (W.H.O., 1980). Serious family tension and isolation also occur amongst deaf persons (Bugliarello, et al., 1976). The indirect connection between noise and mental illness via noise-induced deafness is associated with significantly higher rates of mental illness both in hospital populations and in the community (Mclean and Tarnopolsky, 1977). There is no relationship between hearing loss and mental retardation (Benham-Dunster and Dunster, 1985). High blood pressure (16/100 Hg or above) hypertension, was significantly higher among individuals with noise induced hearing damage (Jonsson, 1978).

Psychological after effects of communication interference

The psychological effects of speech interference by noise are touched on in many publications. All the major surveys of community reaction to aircraft noise comment on the annoyance of having their conversation or verbal entertainment interrupted by aeroplanes (Mclean and Tarnopolsky, 1977). In the U.S. Navy, workers on the flight decks of aircraft carriers indicated irritability, tenseness, insomnia and occasionally fear, because of the inability to communicate with each other in the presence of noise [According to Bugliarello, et al., (1976) based on a study by Davis (1957)].

Speech interference by noise during school lessons leads

to complaints of headaches, tiredness, irritability and lowering of moral in teachers (Mclean and Tarnopolsky, 1977).

Communication interference causes social annoyance. There is considerable evidence that subjects are more annoyed when they have to listen for something during noise or it interferes with T.V. listening or communication (Loeb, 1986). In the work environment if the noise prevents communication, the workers may become isolated. Interaction with others may be less cohesive, which in turn, result in lower job satisfaction (Smith, 1991).

In the light of these studies, there appears to be an indirect connection between noise and psychological problems through noise-induced hearing loss and communication interference. In the on going account the health consequences of noise will be elaborated.

Results and Discussion

The commonest effect of noise is interference with speech (Smith, 1989). It is the most documented of all "extra-auditory" problems (Stream, 1980). Interference affects person-to person or group conversations, television or radio listening, and disrupts formal classroom teacher-students flows of communication (Eguinjobi, 1990). In the present research, 63% of teachers experience speech and 62%

teaching interference (Fig. 5.4). For teaching interference the results for females were similar to those of males (Fig.5.5). The extent of speech interference ranged from 40 to 86% at different schools. The highest interference was reported by teachers at secondary schools (Fig.5.6). In the case of teaching interference, the range varied from 29 to 100%. The highest was reported from high school teachers and schools directly beneath aircraft noise.

The present study supports findings in communities (Loeb, 1986; Smith, 1990) were annoyance is related to communication interference due to noise. In residential areas 40% of respondents stated that aircraft noise interferes with the audibility of radio and T.V., 49% reported it caused T.V. picture flicker and 34% reported interference with their speech (Fig.5.7). Percentage communication interference amongst single and married people seem to vary with the medium (Fig. 5.7.1). Singles reported more interference to audibility of radio and T.V. and their conversation. It may be related to more activities in groups and more watching T.V. and listen radio and cassette player. It seems better educated people have more communication interference due to aircraft noise (Fig.5.7.2). Self employed people complain of communication interference more than other occupational categories (Fig. 5.7.3). People in more noisy areas reported interference to audibility of radio and T.V. and their conversation more than quieter one (Table 7).

effects of aircraft noise on teachers

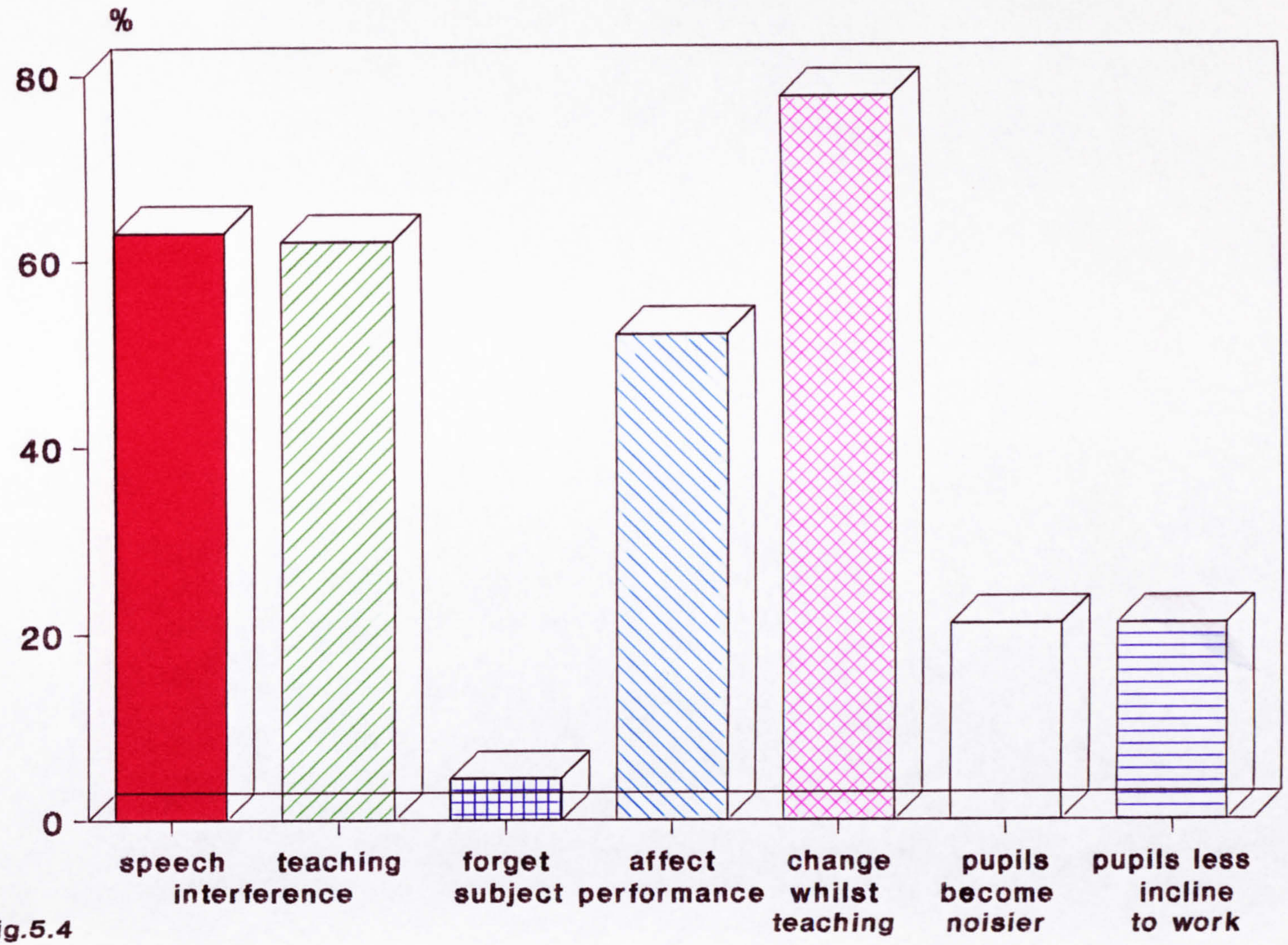

Fig.5.4

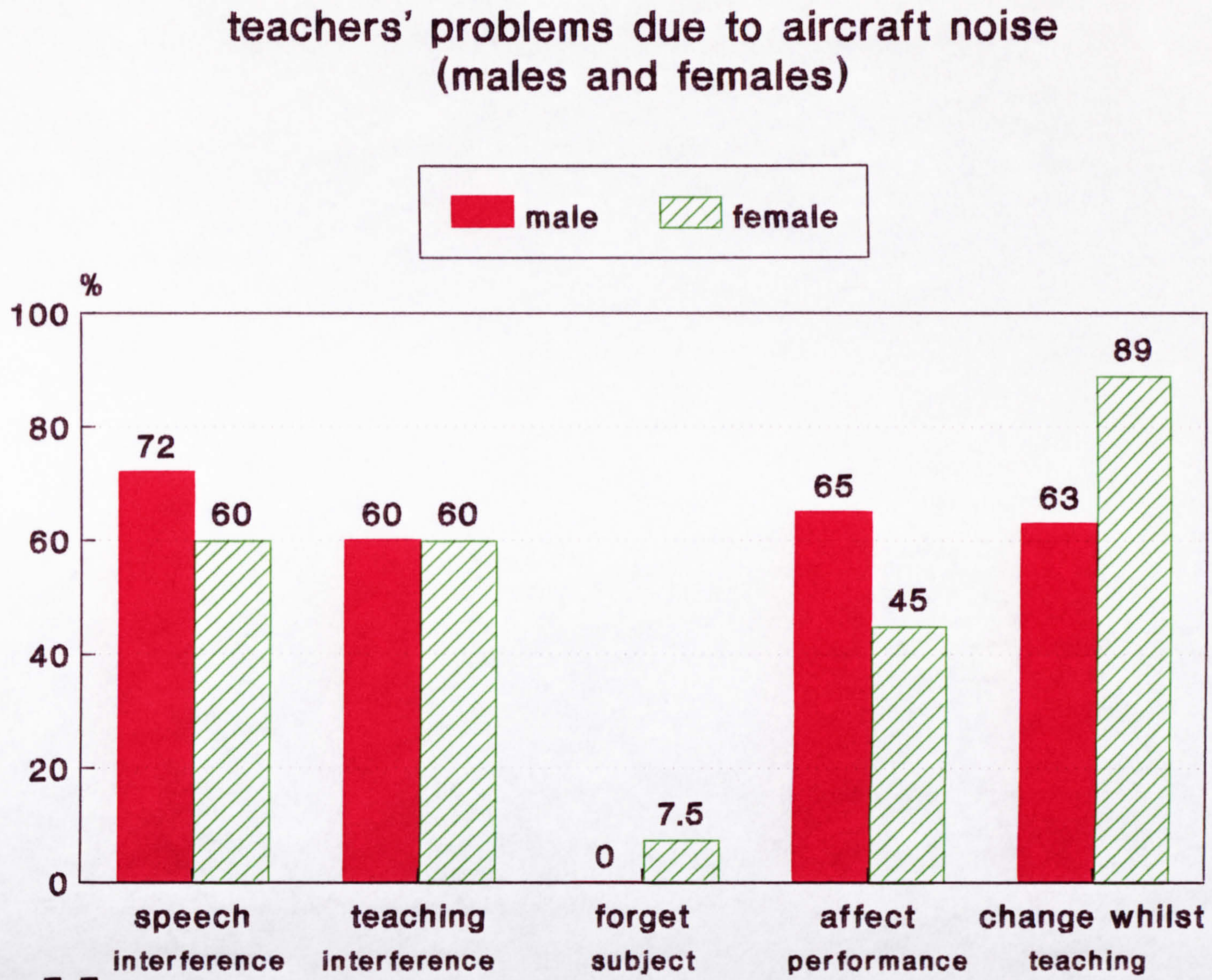
teachers' problems due to aircraft noise
(males and females)
male
female
%
100
80
60
40
20
0
72
60
60
60
0
7.5
65
45
63
89
speech interference
teaching interference
forget subject
affect performance
change whilst teaching

Fig. 5.5.

teachers'problems due to aircraft noise (different grades)

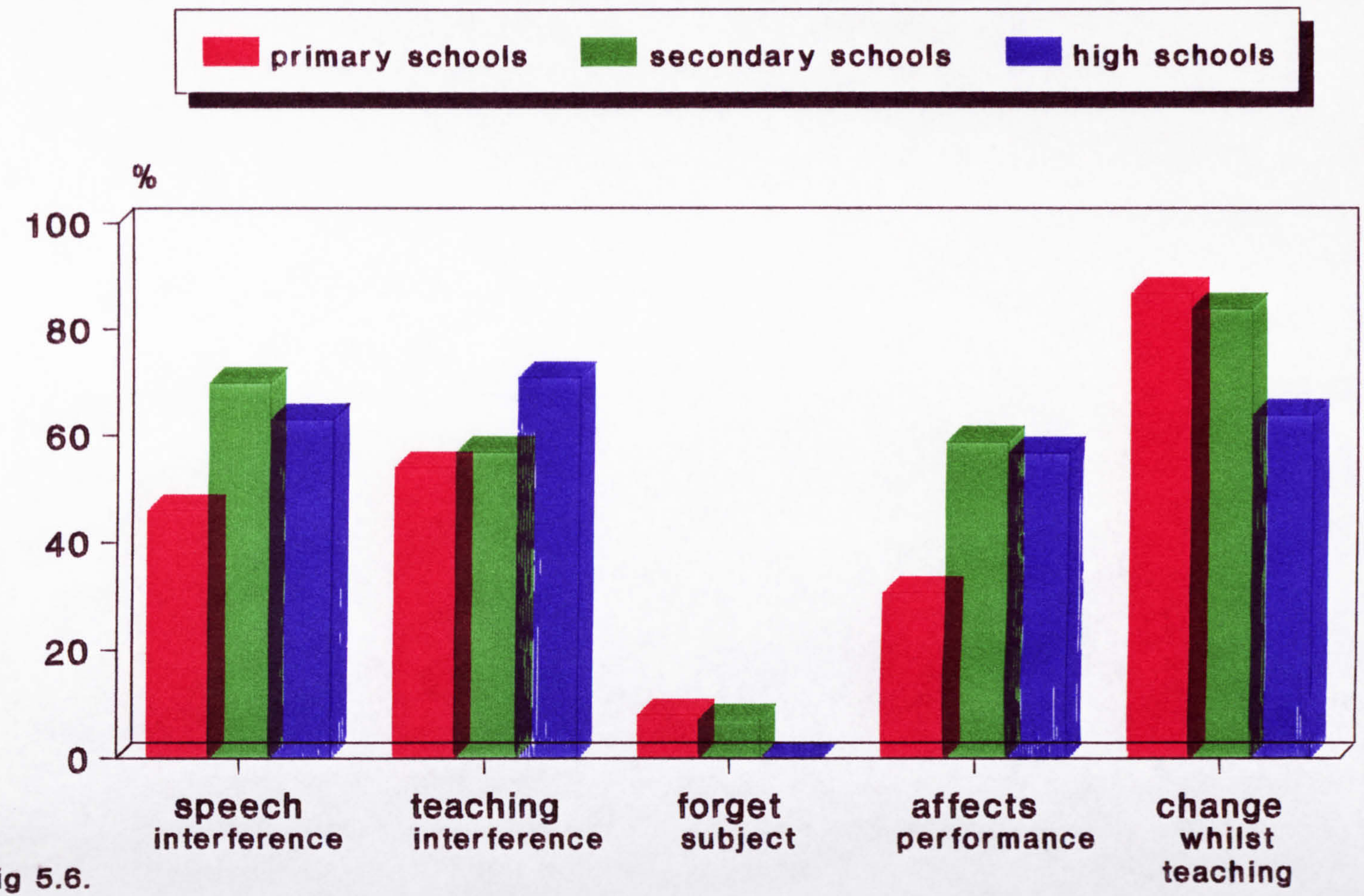

Fig 5.6.

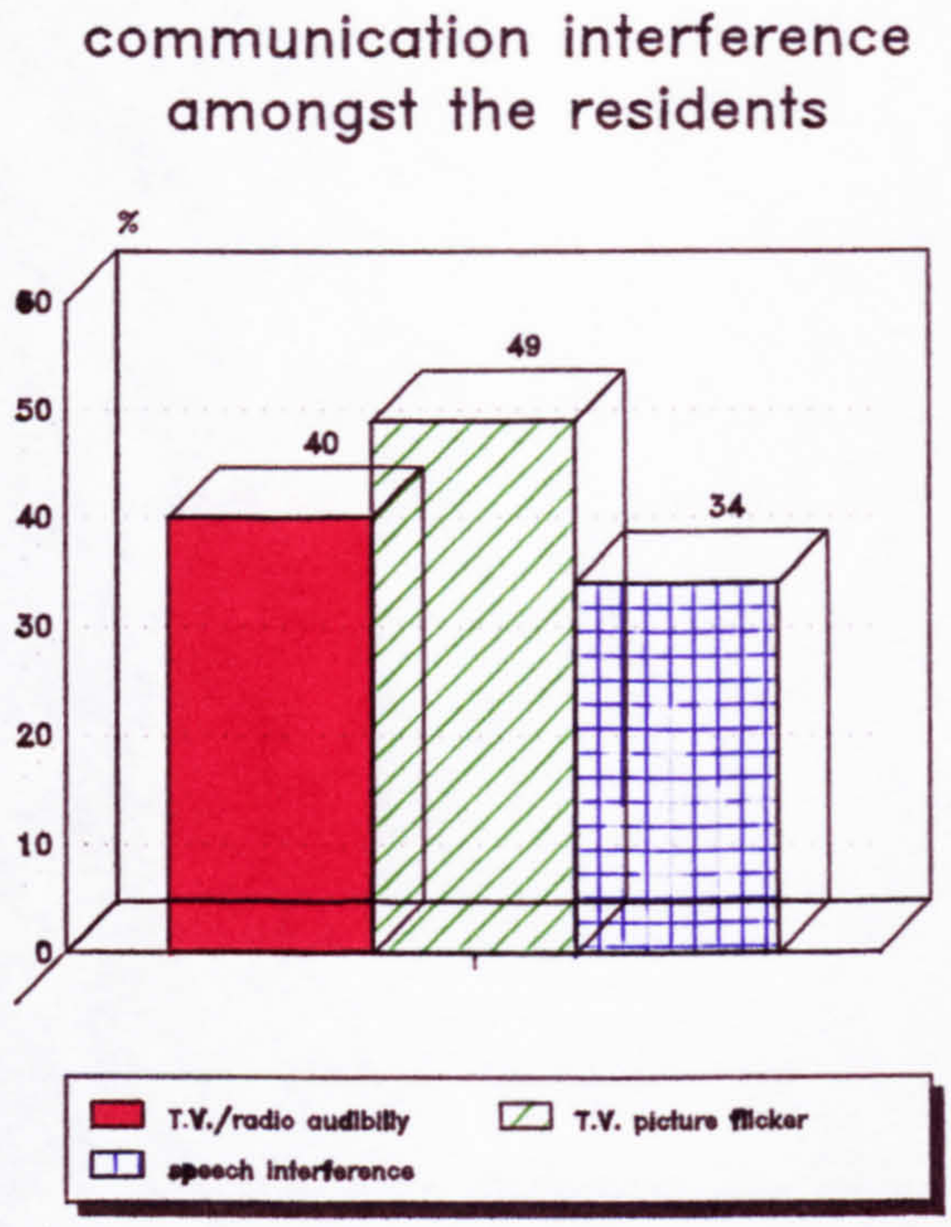

Fig. 5.7.

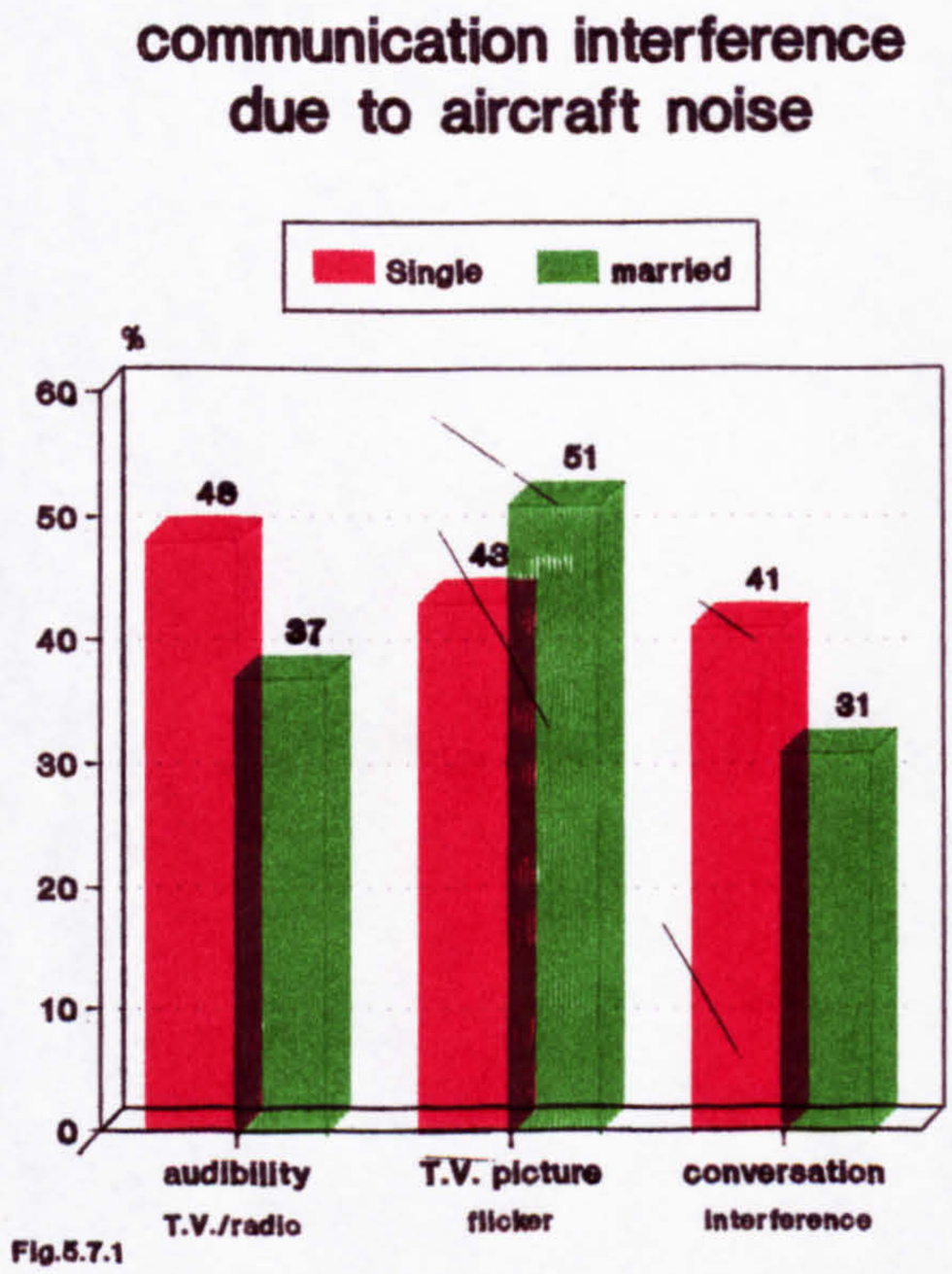

Fig.5.7.1

communication interference and education level

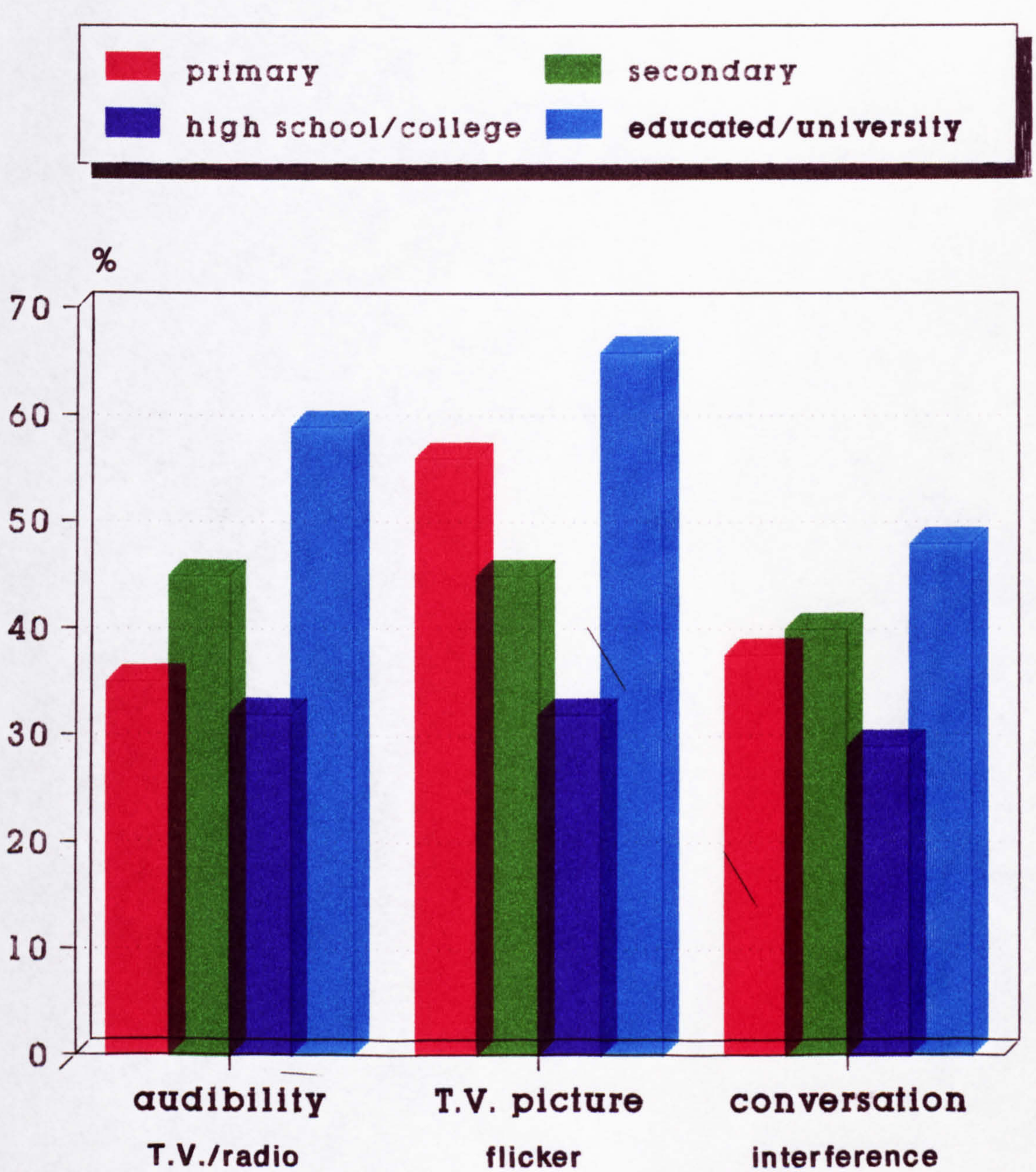

Fig.5.7.2.

communication interference and occupations

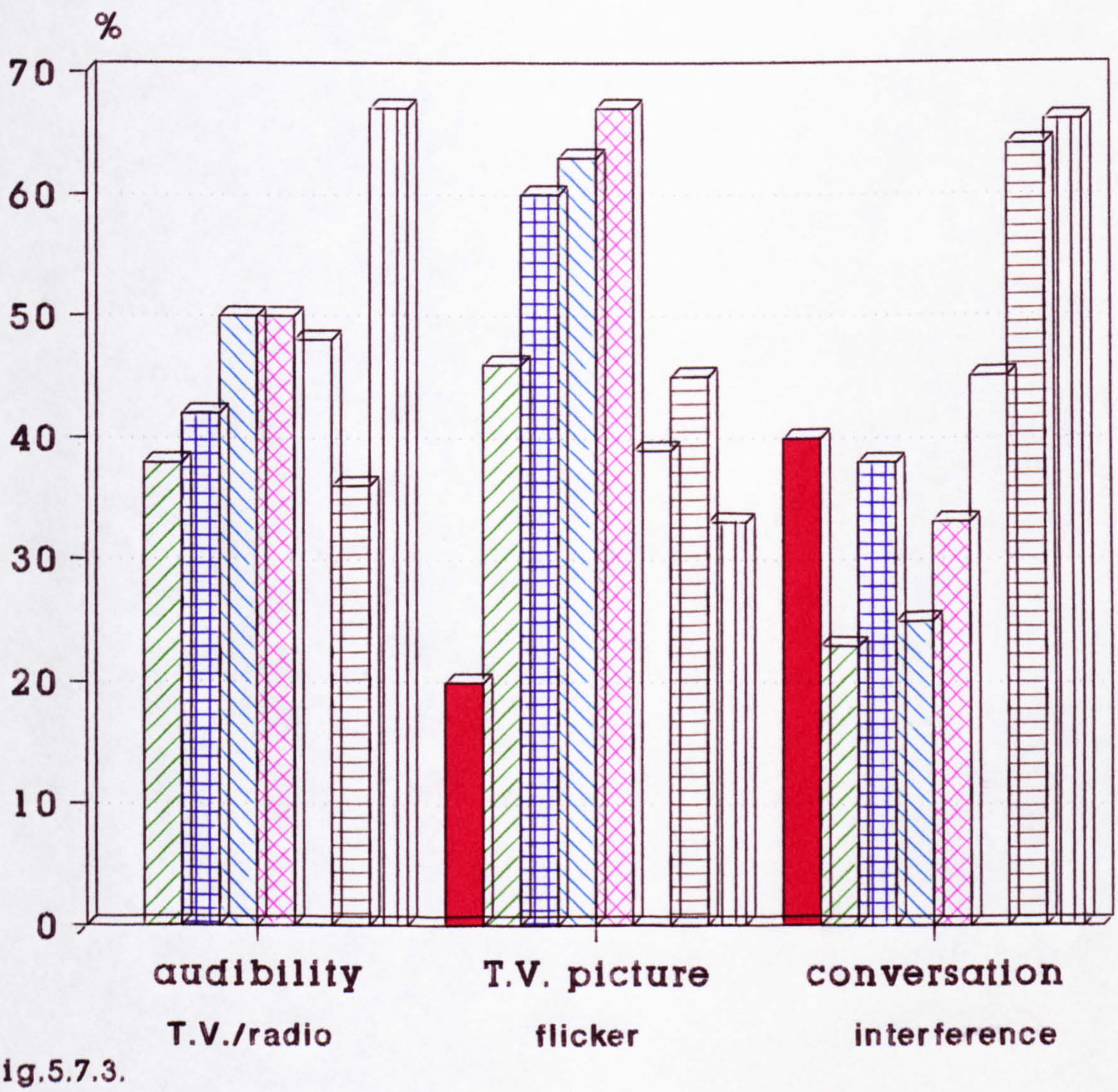

Fig.5.7.3.

Aircraft noise forced about 80% of teachers teaching in institutions close to Mehrabad Airport to abandon lessons or activities (Fig.5.8). Females reported that aircraft noise forced them to abandon lessons more than males (Fig.5.9). Teachers at secondary schools rated that their lessons and activities were more abandoned by aircraft noise than primary and high schools (Fig.5.10). The degree of abandonment at areas with different noise level is presented in Figure 5.11.

lessons' abandonment due to aircraft noise

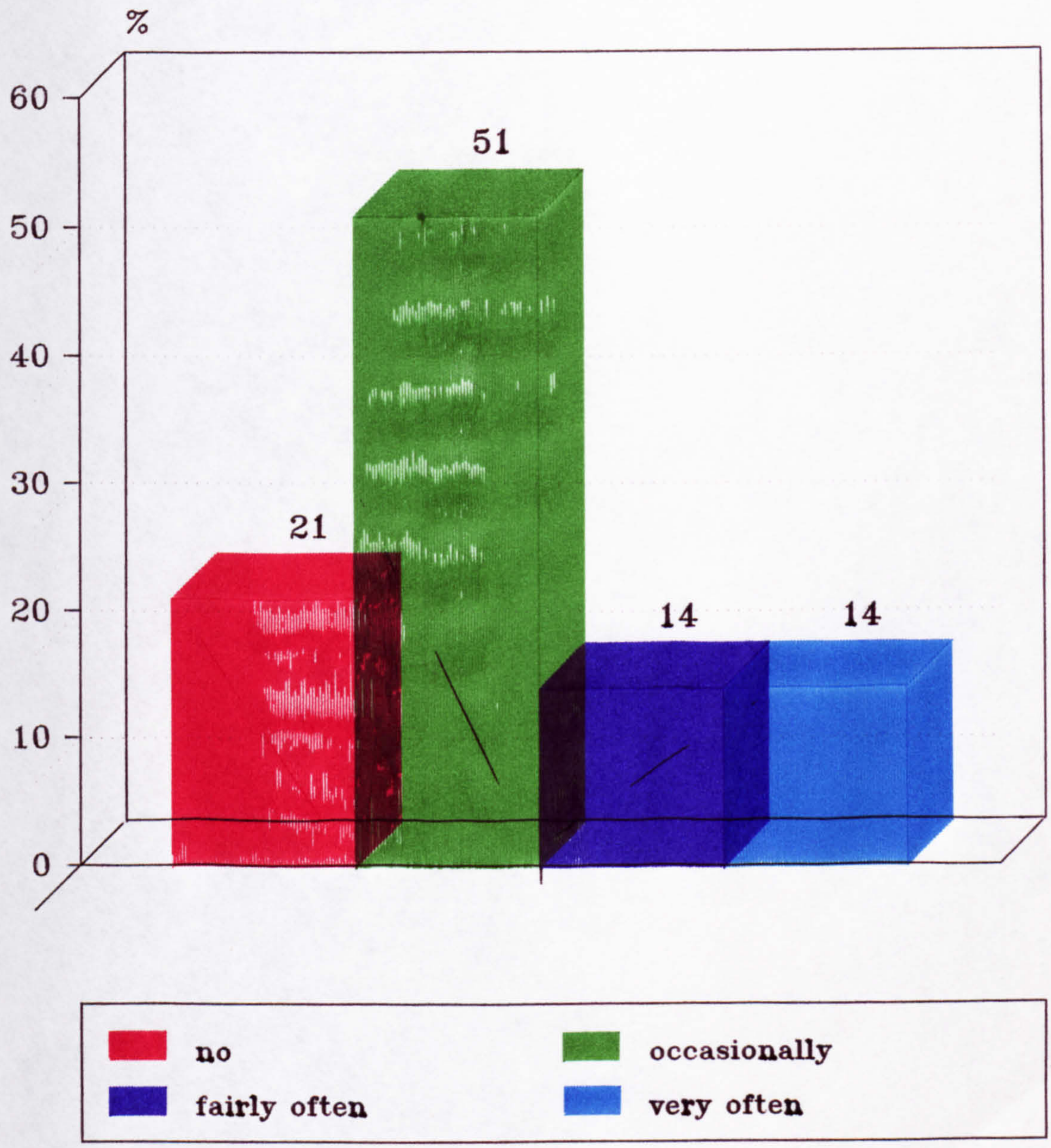

Fig. 5.8 : degree of abandonment

degree of abandonment among males and females

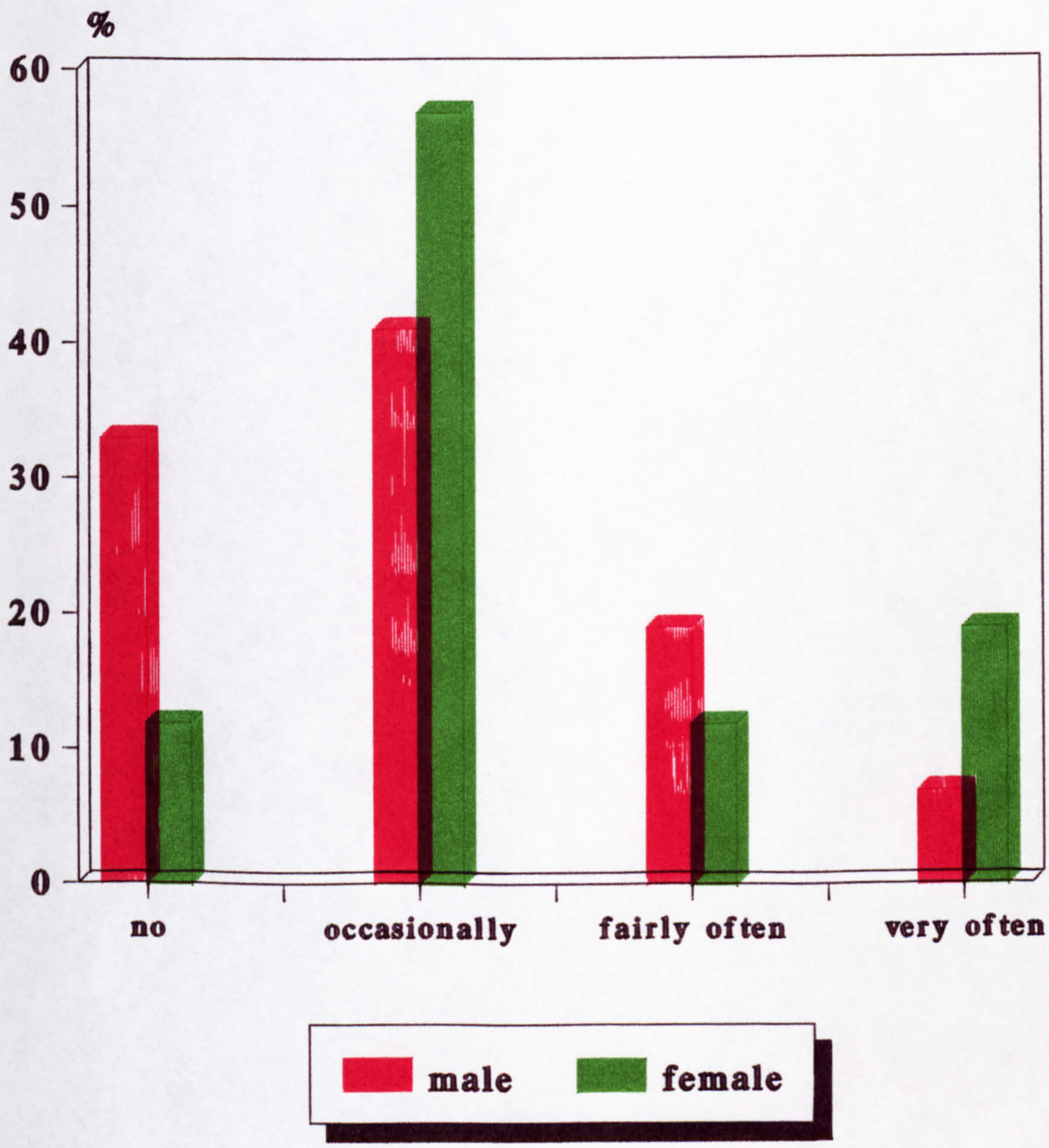

Fig.5.9:abandon lessons and activities

degree of abandonment at different schools

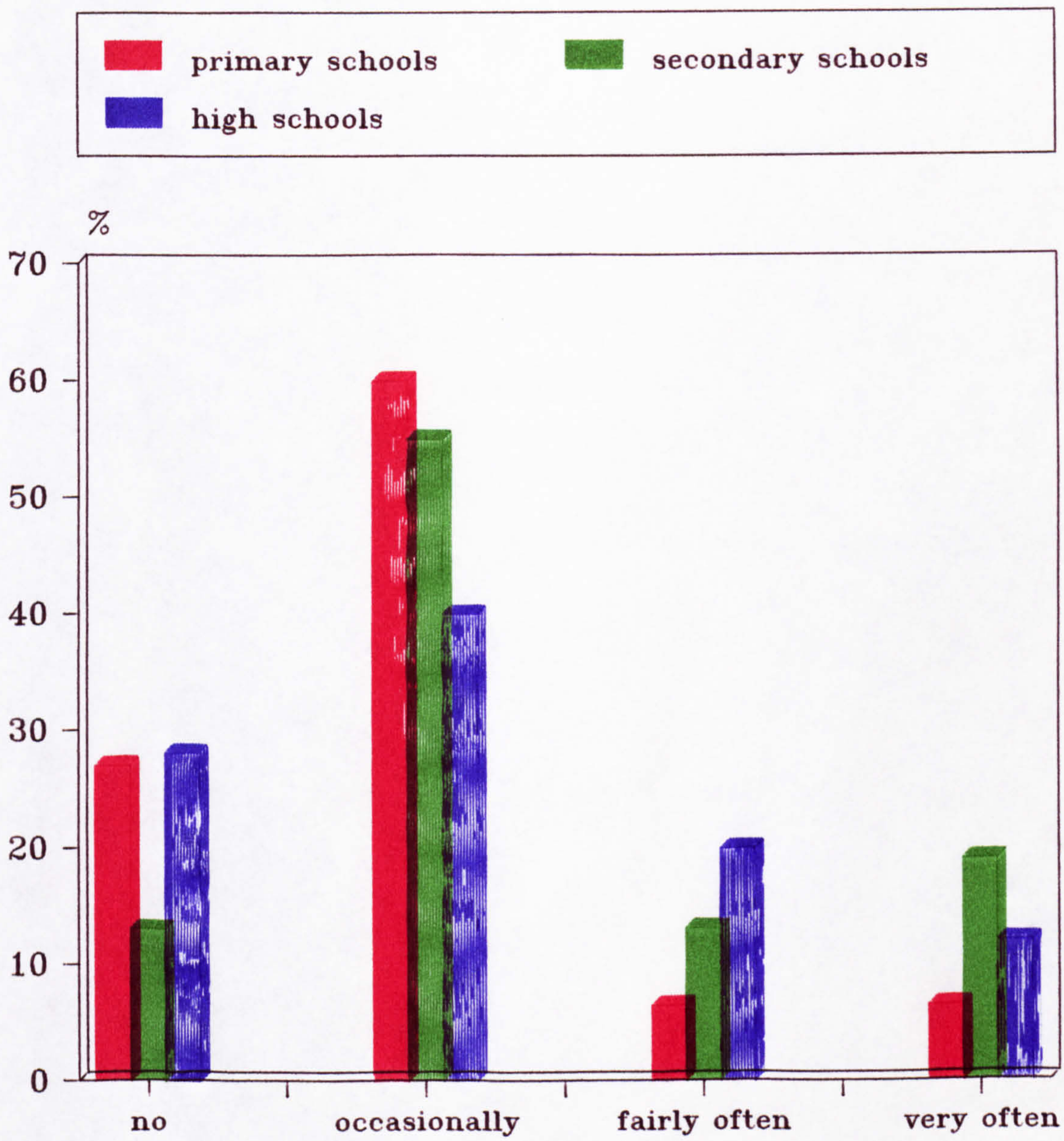

Fig. 5.10: abondon lessons or activities

degree of abandonment at studied areas

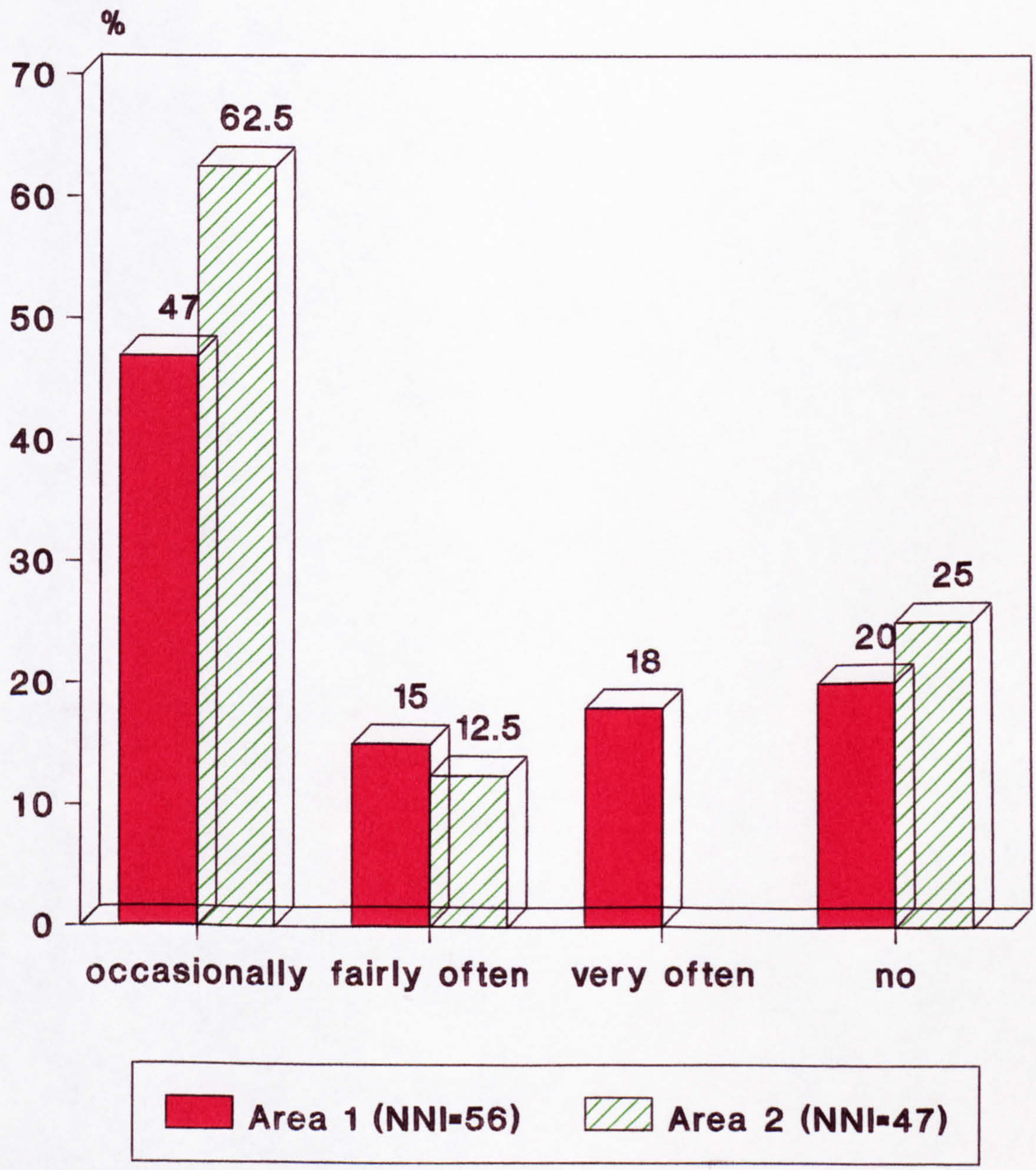

Fig. 5.11: abandon lessons or activities

CHAPTER VI NOISE AND PERFORMANCE

CHAPTER VI

NOISE AND PERFORMANCE

Effect of noise on performance

The effects of noise on performance present a complex and confusing array of findings, inadequate results and conflicting analysis (Dejoy, 1984). Data on the harmful effects of noise on performance conflicts with others which show either, no effect (Bell, 1978; Gawron, 1982 and Pearson and Lane, 1984) or benefit. However, there is a general agreement on the harmful effects of prolonged exposure (Lahtela, et al., 1986). Noise interferes with short term memory tasks (W.H.O., 1980) and also adversely affects matching and incidental memory tasks among children (Cohen and Weinstien, 1981). Noise during learning significantly decreases recall of locations for nonsense words (Fowler and Wilding, 1979). The effect of noise on recall depends on time of day. It had more in the afternoon (Breen-Lewis and Wilding, 1984).

Novel and unusual noises and changes in noise levels often disrupt performance (Dejoy, 1984). The performance of any task which involves auditory cues may deteriorate through noise (Kjellberg, 1990). Some studies suggest that noise improves retention of information (Hartley, et al., 1986; Wilding and Mohindra, 1980 and Breen-Lewis and Wilding, 1984). The effect of noise on attention or

vigilance is critically dependent on the exposure level (Abel, 1990). High noise levels are associated with lower productivity or higher error rates (Kjellberg, 1990). The number of errors increased when the subjects were exposed to 70 *dB(A)* noise for 5 hours (Smith and Miles, 1985). Even moderate levels of noise can impair performance (Gulian and Thomas, 1986). An insoluble puzzle showed that noise affected persistence (Percival and Loeb, 1980).

Every day error studies suggested that subjects in high aircraft noise areas reported more errors of memory in attention and action than those in quiet areas (Smith and Stansfeld, 1986). Those in noisy areas reported much more frequently that they " read something but failed to retain the meaning " than subjects in low aircraft noise area. They also found that noise influences temper, increases anger and produces changes in mood (Jones and Broadbent, 1979). Aircraft noise affects every day activity. The people who were performing tasks under noisy conditions used more heuristics than people who performed similar tasks under quiet conditions (Singer, et al., 1989).

The study on schools near flight paths is important, because teachers and pupils are disturbed by aircraft noise during the whole period of their stay in the school. In comparison the general public which stays in the residential area may work elsewhere (Ko, 1979). However the

interim result of some studies (quoted by Cohen and Weinstein, 1981) showed a positive correlation between school noise level and grade scoring but other studies (Cohen, et al., 1981) have suggested that children who spent a year in noise insulated classrooms had better mathematics scores than children in nonabated rooms. A significant difference, both in performance and behaviour occurred between classes in quiet conditions and classes exposed to noise [55-78 dB(A)] and noise from sonic booms also interfere with eye/hand coordination skills (W.H.O., 1980). Aircraft noise also affects performance of children in tests, as well as their attention and understanding in class. Noisy school children were more likely to fail on cognitive tasks (Cohen, et al., 1980). A poorer reading score was reported (Broadbent, 1978); Cohen, et al., 1973) from the children exposed to high-intensity express way compared to a control group (Bronzaft, 1981). However, Cohen, et al., (1981) there was no significant relationship between aircraft noise and reading ability.

A Hong Kong study (Ko, 1979) has shown that speech and consequential teaching interference due to aircraft noise is attributed to the loss of concentration of pupils. Also the effects of aircraft noise during the test on mentality depends greatly upon the degree of mental concentration (Ando, et al., 1975). If a little concentration is needed to perform a task by pupils, the proportion of "agitated" pupils will be increased by the

noise stimulus only at the beginning of the task. Moreover, learning may be either improved or impaired by noise (Mclean and Tarnopolsky, 1977) and may even produce more organized recall (Hartley, et al., 1986). It seems that the effects of noise depend upon the nature of the task (Smith, 1989). Interference with performance in information gathering and analytical processes have been affected by noise (W.H.O., 1980). The effects of noise on performance have usually been treated within the framework of arousal theory, sometimes supplemented by the hypothesis that attention becomes more selective at high arousal levels (Kjellberg, 1990). Noise may cause arousal (Cohen and Weinstein, 1981) and decrease the willingness to co-operate with others (Mclean and Tarnopolsky, 1977). According to Cohen and Weinstein (1981), Broadbent (1971) showed an elevated arousal by moderate and high-intensity noise. However, Poulton (1978,1979) argued that increasing arousal when continuous noise is first switched on gradually reduces over time. There are several possible reasons for this. Noise distracts attention from the person in need of help, people want to get out of the noisy situation as fast as possible or noise actually makes them irritated and less willing to help (Kjellberg, 1990). Noise also increases frustration and reduces aspiration, regulates effort and influences the perception of competence among the subjects (Smith, 1989).

The visual choice-reaction speed of people will be

slowed down in noisy conditions (Lahtela, et al., 1986). Visual acuity was impaired by loud music at 70 or 107 *dB(A)* but not by other noise at the same level (Ayres and Hughes, 1986). They suggested that the momentary peak levels in music may play a role in disrupting vestibula-ocular control, and that some work place noises may have of this acoustic characteristic. The clear effect of sound on the upper threshold for visual apparent movement demonstrates the interdependence of hearing and vision in perception (Staal and Donderi, 1983).

Several studies treating the effects of noise on safety and efficiency at work places indicate that high noise levels are associated with higher accident rates (Kjellberg, 1990). Several other studies also found a relationship between noise exposure and accidents. Workers in two different plants show a correlation between noise level and increase in accidents was due to deterioration of vision (Ahrlin and Ohrstrom, 1978). Also accident rates in the high-noise areas of a plant were more than in low-noise areas (Cohen, 1973). In the follow-up phase of this study the number of accidents decreased after a hearing protector programme was introduced. A study in a cotton plant in North Carolina by Schmidt, et al. (1982) showed statistically significant lower injury rates after with hearing protection devices in comparison with control group. They suggested that reduction in injury rate for an industrial population exposed to daily noise levels from

92 to 96 dB should be expected. A reduction in injury rate following the introduction of a hearing conservation programme in a textile plant (Dejoy, 1984). A review of noise and accident . suggested that the possible link related to lack of attention or carelessness in noisy places (Wilkins and Acton, 1982) and narrowing of the visual field (W.H.O., 1980).

Studies in England (Crook and Langdon, 1974) and in Hong Kong (Ko, 1979) showed that aircraft noise affects the performance and efficiency of teachers. This study also has studied the effects of aircraft noise on teachers in institutes around Mehrabad Airport, Tehran , Iran.

Results and Discussion

52% of teachers rated that aircraft noise affects their performance and 77% were forced to make changes whilst teaching when aircraft flew over (Fig.5.1). For comparison the gender difference between respondents percentages were compared (Fig.5.2). Respondents were asked if they changed their teaching when aircraft passed. they stopped teaching, raised their voice and closed windows but no classes were cancelled due to aircraft noise (Fig.6.1). Both males and females reported that they were more likely stop their teaching . However the percentage of males was

changes whilst teaching

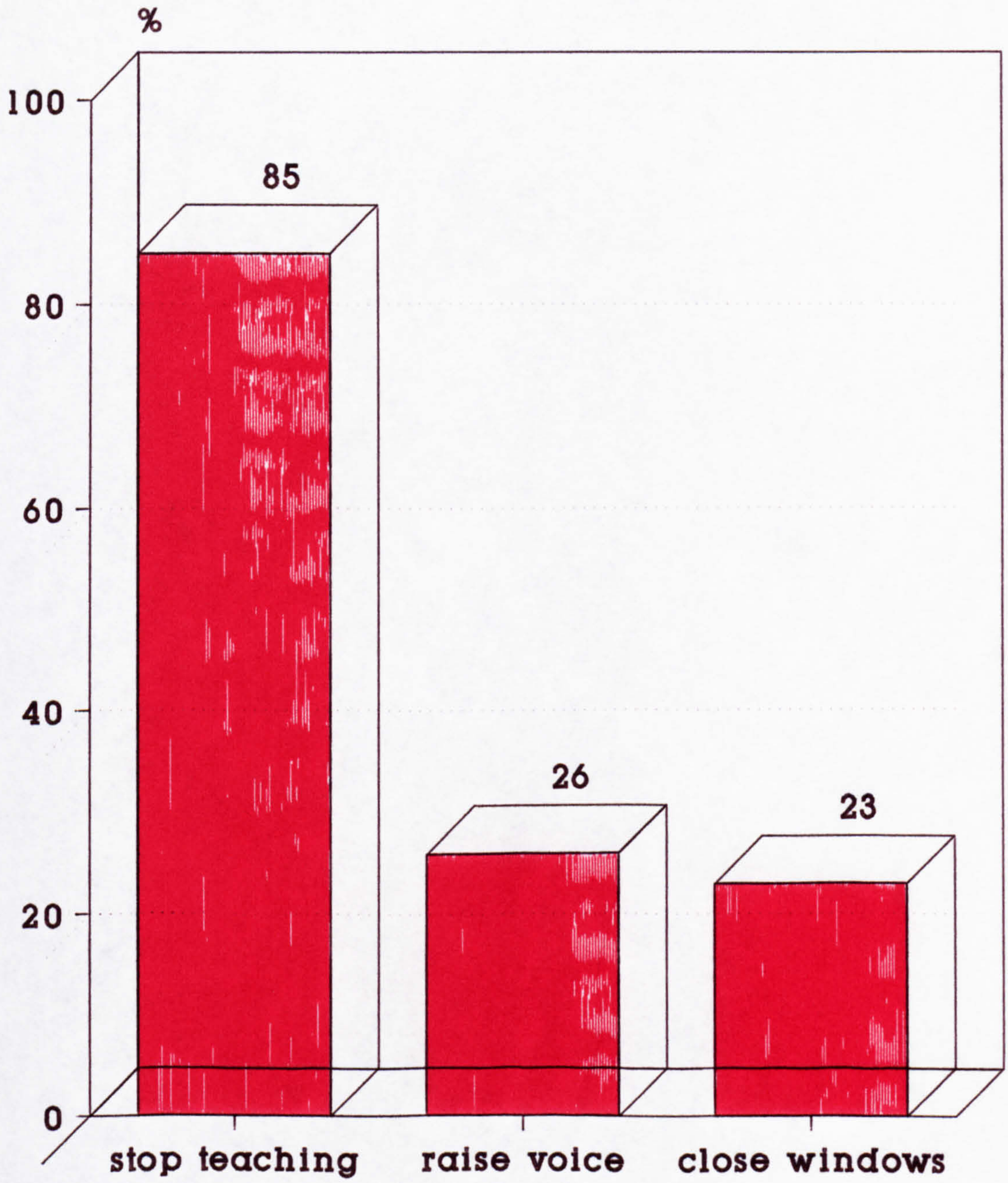

Fig. 6.1 :changes due to aircraft noise

higher than females (Fig.6.2). The percentage of teachers who reported changes whilst teaching due to aircraft noise at different grades (primary, secondary, high schools) has been presented in figure 6.3. The figure shows that teachers at all grades stop their teaching more than other changes due to aircraft noise.

95% of teachers were not affected by aircraft noise causing them to forget subjects or activities (Fig.5.4). From those who reported effects of aircraft noise on these aspects all were from the primary and secondary schools (Fig.5.6). Speech and teaching interference due to aircraft noise causes loss of teachers' concentration and listener attention (Crook and Longdon, 1974). In the present study 21% of respondents believe that aircraft noise causes pupils to become more noisy and less inclined to work or be active. From those the proportion of primary school was 23%, while it was 13% for secondary and 29% for high schools (Fig.6.4). 32% of teachers who were teaching at boys schools reported aircraft noise caused pupils to become noisier and 24% rated that they were less inclined to work and be active. The percentages for girl schools was 15% and 18%.

The duration of teachers' service was compared for assessing the effects of aircraft noise on efficiency and the performance of experienced and new teachers. The results show no significant differences between the

changes due to aircraft noise (male/female)

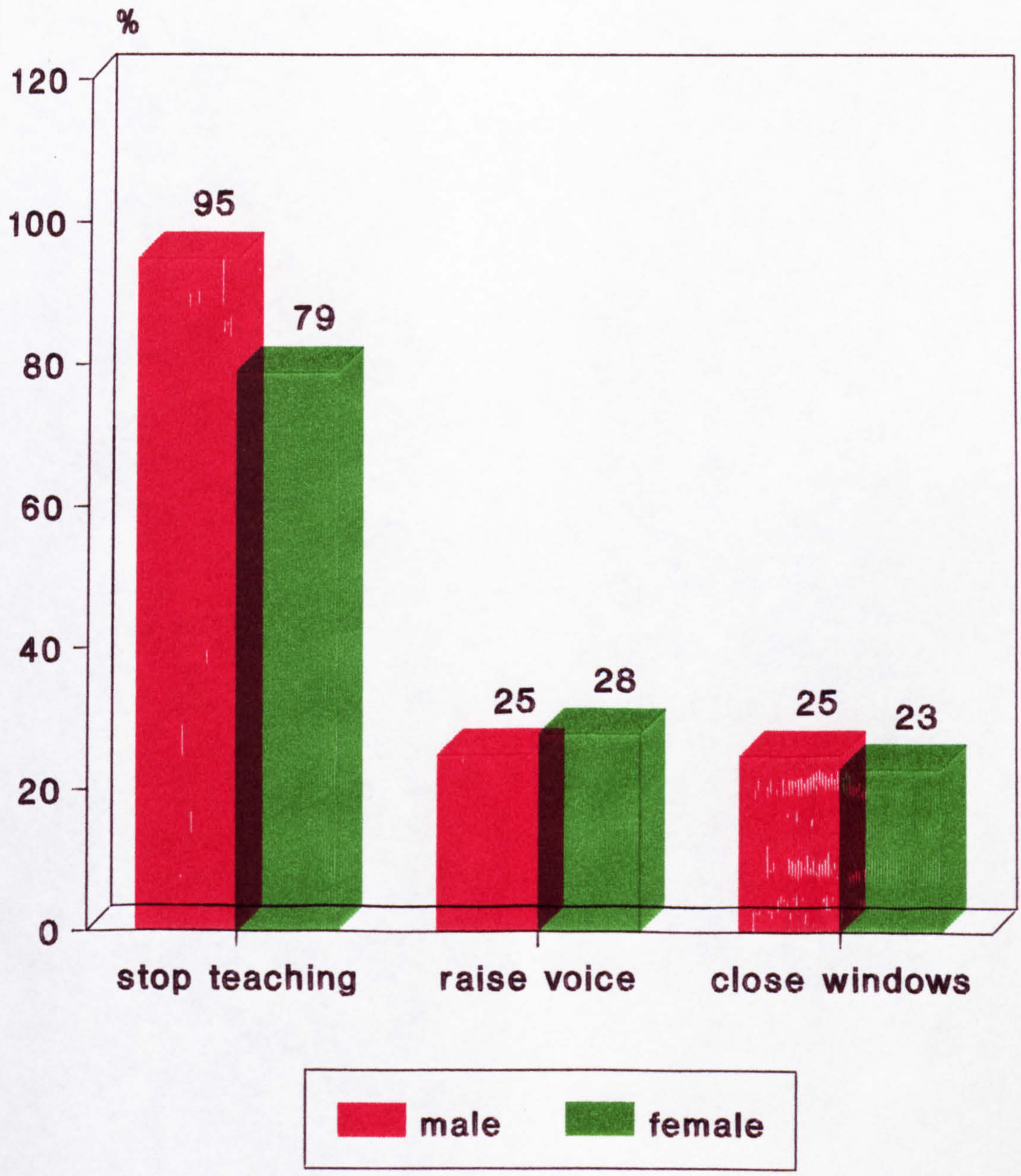

Fig.6.2.

changes due to aircraft noise at different grades

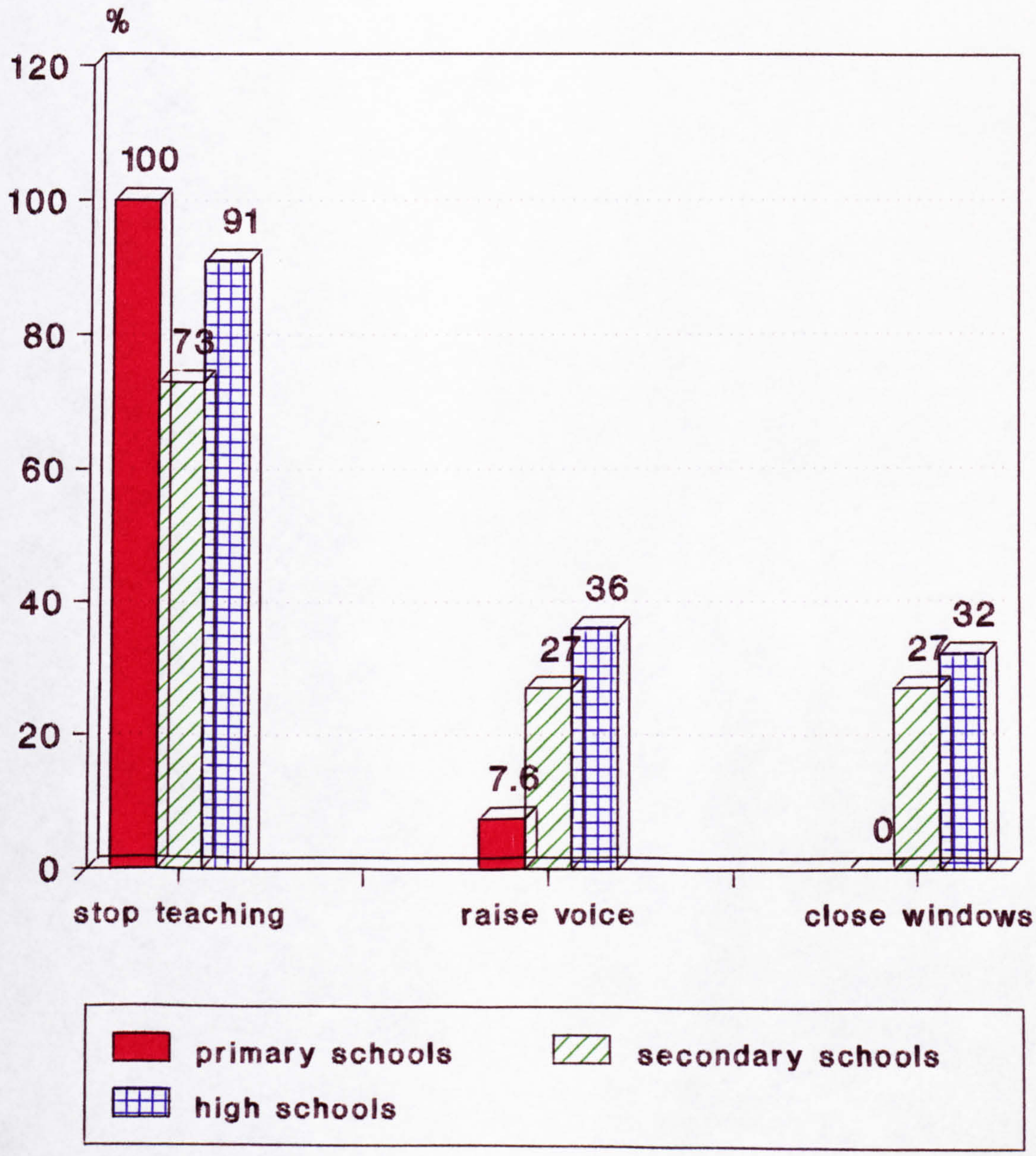

Fig.6-3 : changes whilst teaching

pupils behaviour due to aircraft noise

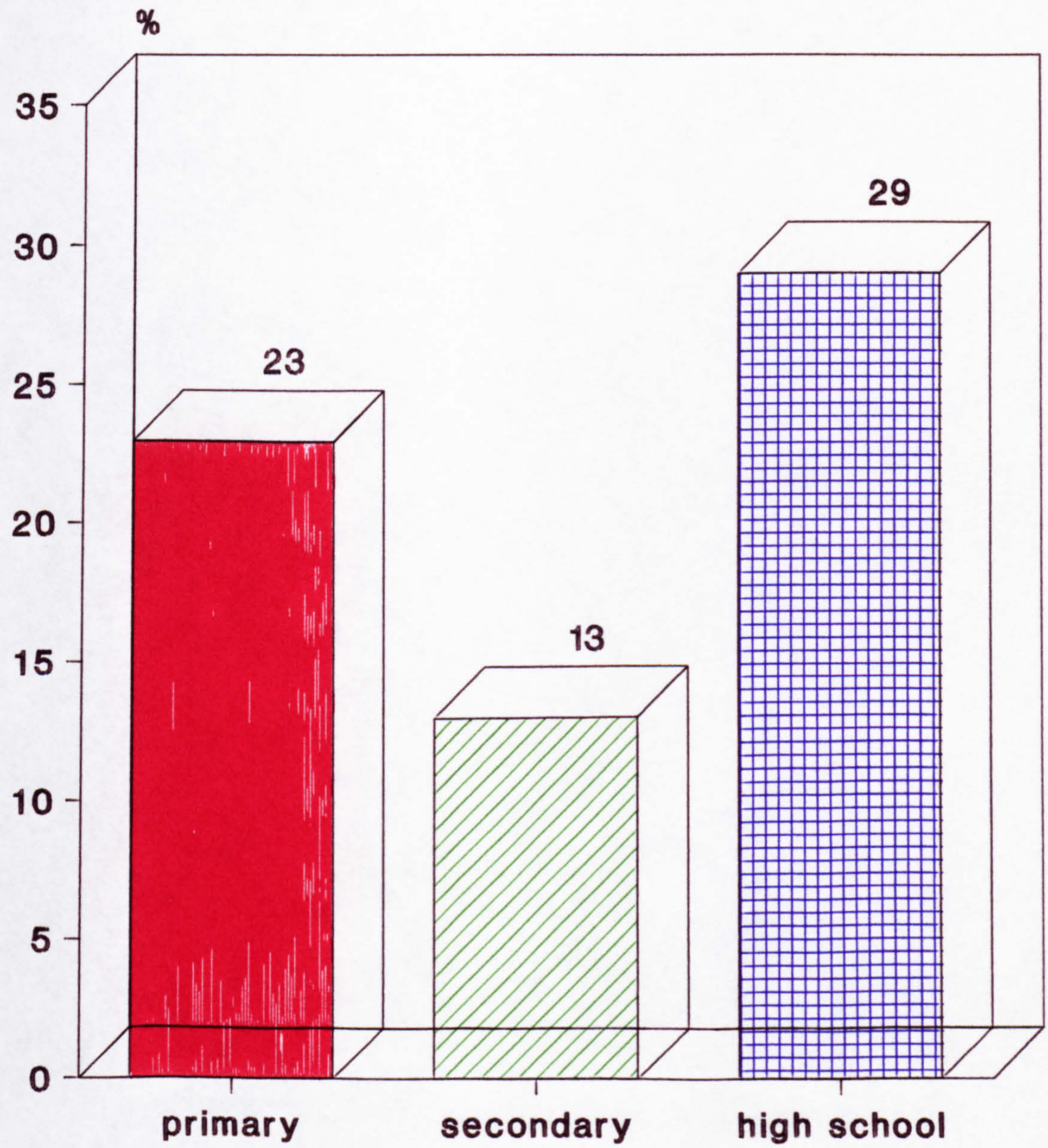

Fig. 6.4 : noisier and less inclined to work and activities

teachers with more years of services and the less experienced teachers. Where aircraft noise changes teaching technique of experienced teachers, it causes the same change amongst new teachers (Fig.6.5). The teachers cannot habituate to aircraft noise. It affects the performance , teaching and activities of new teachers as well as teachers who have worked in the area for a long time. Even after more than 10 years teaching at the same schools, aircraft noise is still a factor which affects the teachers' performance similar to the new teachers (Fig.6.6).

teaching problems and years of service

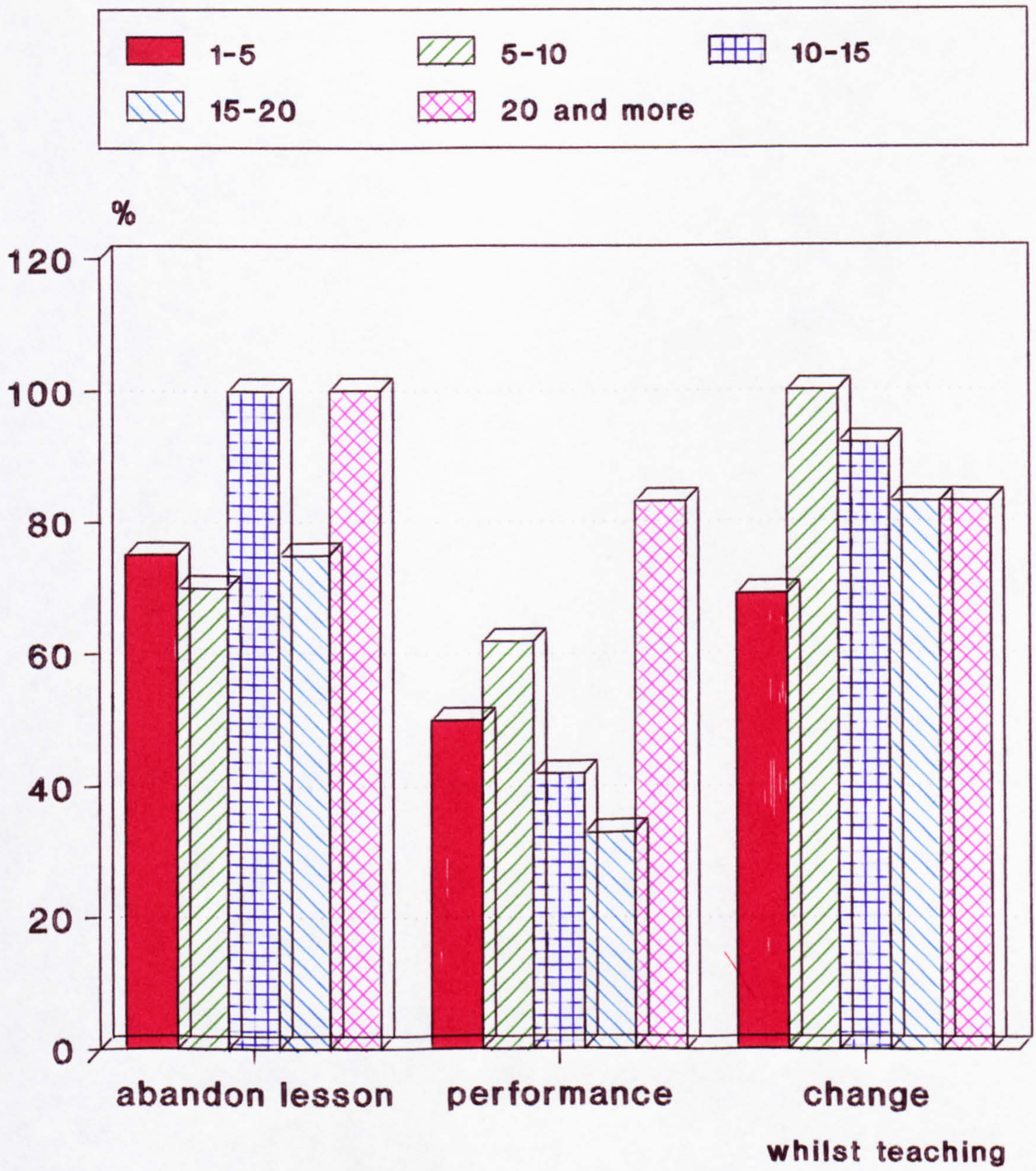

Fig.6.5.

teaching problems and years of service at studied schools

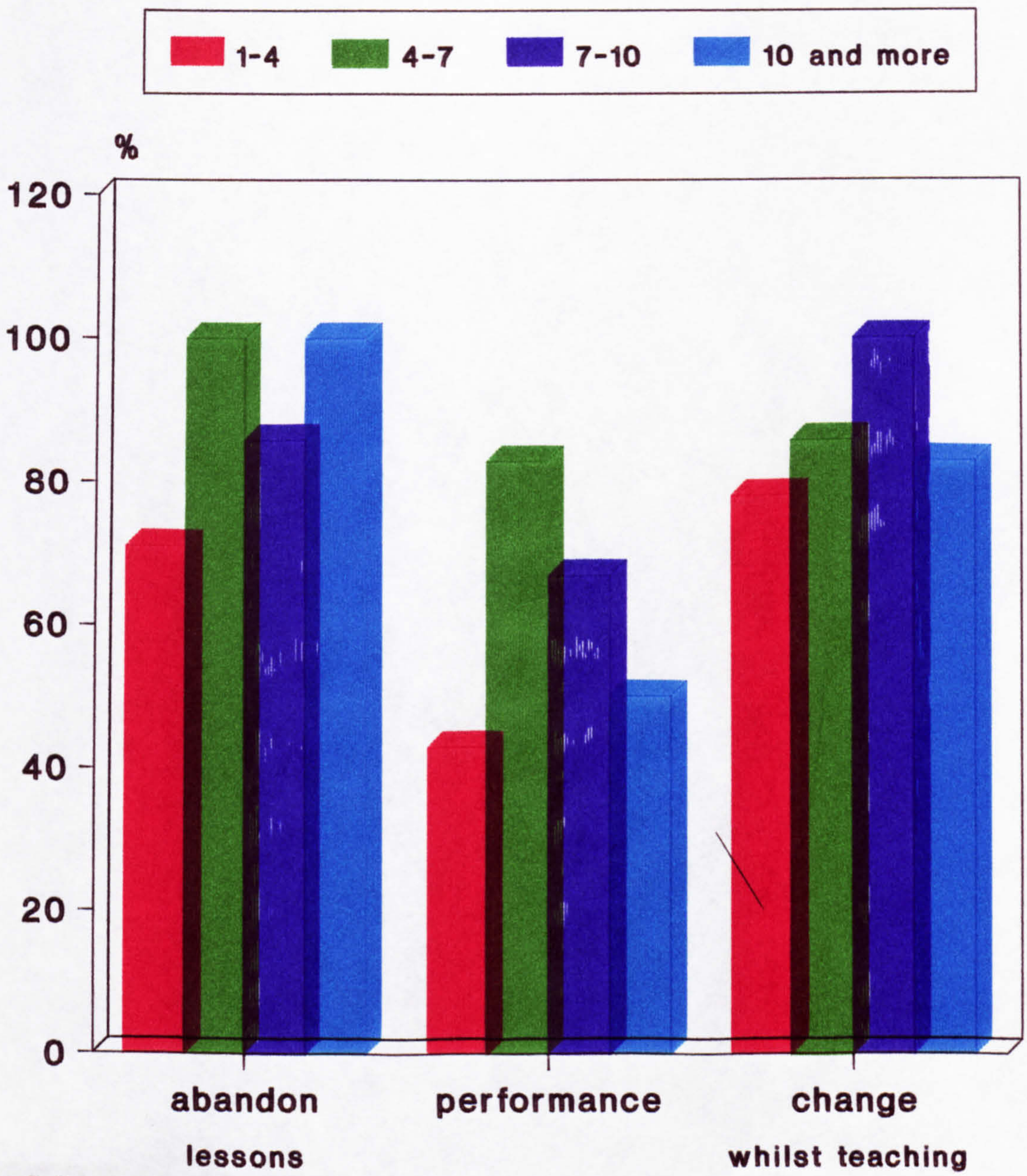

Fig.6.6.

CHAPTER VII NOISE AND ANNOYANCE

CHAPTER VII

NOISE AND ANNOYANCE

Introduction

Annoyance is a common psychological response to noise (Mclean and Tarnopolsky, 1977 and Tarnopolsky, et al., 1980). It may be defined as, feeling of being bothered plus the presence of noise disturbing activities . Other definitions also suggest that annoyance means reactions exhibited by people exposed to unpleasant experiences. In the 12th report of W.H.O. (1980), about environmental health criteria, annoyance has been defined as a feeling of displeasure associated with any agent or condition known or believed by an individual or a group to be adversely affected. This report also suggested that annoyance is related to the direct effect of noise on conversation, mental concentration , rest or recreation.

Noise effects

Stansfeld, et al.,(1985) proposed that exposure to noise had been associated with the display of annoyance which interfered with every day activities and caused stress symptoms such as fatigue and headache. Cohen, et

al., (1986) suggested that daily exposure to environmental stressors can create annoyance and decrease the quality of life for those who view it as unnecessary and uncontrollable. Disturbance of sleep (Stream, 1980) by noise is often the underlying reason for noise annoyance. Speech interference by noise is also annoying (Mulholland and Attenborough, 1981) and communication interference causes widespread annoyance in society (Loeb, 1986; Smith, 1990).

Annoyance with aircraft noise has often been associated with fear and the belief that the noise could be prevented if adequate measures were taken (Fields and Walker, 1982). Lesser annoyance with railways may be explained by more positive attitudes toward railways.

Respondents living directly underneath a flight path are more annoyed than people living outside the path (Gjestland, 1988). In other words aircraft perceived as flying overhead were more annoying than those perceived as flying off the side (Gunn, et al., 1981 and Gunn, 1987). They suggested that may be that fear of crashes in the neighbourhood are an important factor for generating annoyance at aircraft noise. Moran, et al., (1981) reported on two areas (crashed and noncrashed) around Albany Airport (New York) and Louisville Airport (Kentucky) in perception of air traffic hazard . Aircraft hazard,

aircraft noise and noise in general concerned both groups, however, concerns were greater in term of fear and annoyance for people in the crashed area. Stansfeld, et al., (1985) also confirmed that fear of the aircraft crashing as a factor of annoyance response to aircraft noise as well as the belief that aircraft noise impairs health. It was also shown that complaints about aircraft noise come from those people who are afraid to fly or who fear that aircraft will crash on their house. This means that the noise, not its intensity (Broadbent, 1980) is significant. Residents around Hamburg and Munich Airports suffered nervousness as a result of aircraft noise (Penn, 1979). The fear of aircraft crashes is a psycho-social factor among residents around airports. It is an important factor for generating annoyance to aircraft noise and the belief that it impairs health (Stansfeld, et al., 1985; Gunn, 1987; Gunn, et al., 1981). The factors which could be a cause of aircraft noise reaction were studied around seven major airports in the U.S.A. by Tracor Inc. (1971). Fear of aircraft crashing was the most important factor which influenced aircraft noise reactions. It is clear that aircraft noise causes a reaction of fear, consequently a state of unsecured as an important factor in the psychological aspect of human life (Hade and Bullen, 1982).

Studies on residents around two airports in Canada, Toronto (International) and Oshawa (Municipal) by Taylor, et al. (1981) showed the percentage of people highly

annoyed was considerable for both airports. A joint study carried out in France, Netherlands and United Kingdom showed 80% people annoyed at 55 NNI (Vellet, et al., 1988).

Interference with activities might be a source of greater annoyance wherein successful achievement of the activity is highly valued by the subject (Levy-leboyer and Moser, 1987). The surveys around Heathrow Airport (London) show annoyance caused by interference with a number of activities (Bugliarello, et al., 1976). Cheifetz and Borsky (1980) suggested that annoyance is associated with the noise level, type of activity or context is also important. Annoyance was a direct effect of noise on various activities such as , interference with conversation, mental concentration, rest or recreation (W.H.O., 1980).

Several have investigated the relationship between specific noises and annoyance such as aircraft noise (McKennel,1963; Gunn, et al., 1981; Moran, et al., 1981; Smith and Stansfeld, 1986 and Vallet, et al., 1988), train noise (Ahrlin and Rylander, 1979; Clegg, 1979) and traffic noise (Langdon, 1976, and Rylander, et al., 1976), industrial noise (Ohrstrom and Bjorkman, 1978, and Melamed, et al., 1988) and power lines noise (Lerner and Lehrman, 1981). The overall results established a correlation between noise and annoyance, which is probably more readily associated with noise than nonauditory problems (Stream,

1980). Hall, et al., (1981) have showed that a greater percentage of people were highly annoyed by aircraft noise as compared to road traffic noise for the same noise level, whereas according to a review by Broadbent (1980) vehicle noise is more annoying than aircraft noise . Ahrlin and Rylander (1979) also found higher extent of annoyance for road traffic and lower for train and tramway compared to aircraft noise. A comparative review by Field and Walker (1982) between different noises and annoyance showed that aircraft were more annoying than road traffic and railways. A study by Rohrmann (1978) in Hamburg (Germany) showed that people are more annoyed by aircraft noise than other sources of urban noises. The people believed that aircraft noise were 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. In England over the years there have been few complaints about railway noise, yet sound levels generated along railways are higher than levels from various other sources which frequency give rise to wide spread complaints (Clegg, 1979). A social survey by Fidell and Silvati (1991) on prevalance of annoyance in Hartsfield 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.

The significance of aircraft noise is illustrated by a survey conducted in U.S.A. by Environmental Protection Agency (1974) . The reasons were given for wanting to move from a given location for day-night noise level (Ldn) > 68 *dB(A)*. Aircraft noise was the main reason given by the highest percentage in the survey between reasons which respondents had given as : climate, better living accommodation, smoke/dirt/smells and distance from work (Wilson, 1989).

The interim results of some studies conducted in France, Netherlands, Germany and Japan showed that annoyance increased with increasing number of over flights and noise level (Rylander, et al., 1976). Studies on four French airports showed a very high correlation (0.93) between the averages of the annoyance scores and noise level (Bugliarello, et al., 1976). Cheifetz and Borsky (1980) suggested that noise level was the most important variable in determining annoyance. The change in noise levels is an important factor for change the degree of annoyance and dissatisfaction with aircraft and traffic noise (Raw and Griffiths, 1985; Griffiths and Raw, 1986). Other studies conducted in Sweden (Rylander, et al ., 1976) showed a correlation between traffic noise level and the extent of annoyance. The number of vehicles was an important factor in promoting annoyance and a relationship existed between extent of annoyance and number of over flights. Stansfeld, et al., (1985) suggested that noise

exposure particularly to aircraft noise, was significantly related to high annoyance . Garcia, et al., (1988) compared the neighbourhood noises with satisfaction and found that the satisfaction level was significantly higher in quiet areas than in noisy areas. Traffic noise affected more people than other neighbourhood noises like pubs, restaurants and other noisy activities . Utley and Keighley (1988) classified noises on the basis of extent of their disturbance capacity as traffic noise, aircraft noise, electronically produced sounds, vocal sounds, impact sounds (banging doors, footsteps) and animal sound . In France Levy-Leboyer and Naturel (1991) showed that the most annoying noises were those which are judged as being not normal, possible to avoid, happening during the night, and described as being loud. Feeling of annoyance may partly be caused indirectly by the subjects awareness of his impaired performance in noisy areas (Arvidsson and Lindvall, 1978).

Studies by Sargent, et al., (1980) on effects of noise on teachers show that above a level of 59 *dB(A)* a higher proportion of teachers was bothered by road traffic noise than by noise from any source within the schools. They suggested that with external level of 65 *dB(A)* about 60% of teachers were bothered "quite a lot" or "very much". The effect of aircraft noise on teachers at Kai Tak International Airport (Hong kong) show 64.5% cited aircraft noise as most annoying and 22% cited traffic noise. Studies

on residents around four new airports in Japan (Izumi, 1988) in duration 1972-1982 showed significant decreases of high level annoyance responses from the first year of opening of airports to third years among the students of assigned local school . The annoyance responses steadily followed the changing rate of air transportation after this period. According to Mclean and Tarnopolsky (1977), Rylandet, et al., (1972,1973) in a field studied army recruits and the local population subjected to 7 real sonic booms per night. 3% of recruits and 40% of civilians rated themselves "very annoyed" . Noisy school children were more bothered by aircraft noise than quiet school children both in the classroom and at home (Cohen, et al., 1981). A study conducted in Sweden (Gothenberg) by Ohrstrom and Bjorkman (1978) indicated that 75 % of the workers in machine industry and 46 % in textile industry were annoyed by noise. Melamed, et al., (1988) suggested, Lower job satisfaction, higher somatic complaints, irritability and anxiety among worker reporting high noise annoyance than those who reported low noise annoyance. Studies also show, the proportion of persons with headache, insomnia and nervousness increased strongly in the highest annoyance (Mclean and Tarnopolsky, 1977). Loeb (1986) also suggested irritability, headaches depression and desire to escape from noise as being classic symptoms of noise annoyance.

It seems that there is a relationship between personality and the extent of annoyance. Accordingly people

may be divided into three groups, being very annoyed (being intensely bothered), annoyed only to a moderate degree and the third being relatively insensitive (Mclean and Tarnopolsky, 1977). these differences being related to personality characteristics (Gunn, et al., 1981 and Tarnopolsky, 1978). A significant relationship between noise annoyance response and personality variables was reported by Shigehisa and Gunn (1979). These differences were intraversion-extraversion, neuroticism (emotionality), psychoticism (toughmindedness) and some stable personality factor or social naivety in relation to conditions of illumination. However these may be random variation due to the measuring instrument not detecting individual differences (Griffiths and Delauzun, 1977). Annoyance towards noise not only depends on the person but on the situation in which the noise is perceived (Weiler, et al., (1981). For instance, it would seem reasonable to say that motorcycle noise could be pleasant to a teenage motorcycle rider but unpleasant to a neighbour.

To sum up there is a positive correlation between the extent of annoyance and noise . Noise could be a hazard through its effect on human health, because it is a forerunner of nervousness and an indicator of predisposition to mental illnesses (Tarnopolsky, 1978).

Results and Discussion

The over all teachers' responses to aircraft noise ranged from "not at all annoyed" to "very much annoyed". Aircraft noise exposure causes " a little" to "very much" annoyance among 91.5% of teachers (Figures 7.1 and 7.2). this includes 67% of teachers teaching at primary schools, 90% in secondary schools and 84% in high schools (Fig.7.4). Females are more annoyed than males (Fig.7.3).

35% of teachers who would like to change schools rated aircraft noise as cause. From this 30% was female and only 5% was male. The higher proportion who disliked their teaching place were teachers in primary schools (36%), with 30% in secondary and 24% in high schools.

The level of annoyance amongst residents (Fig. 7.5) showed 91% of people are annoyed by aircraft noise "a little" to "very much". 43% were " highly annoyed" (Fig.7.6). No significant gender differences were found in the degree of annoyance amongst the residents, but the women teachers were significantly more annoyed than males. 86% of women residents and 95% of men residents of the local area and 98% of women teachers and 81% of men teachers indicated annoyance. About 75% of residents have lived in their area for 10 years or more.

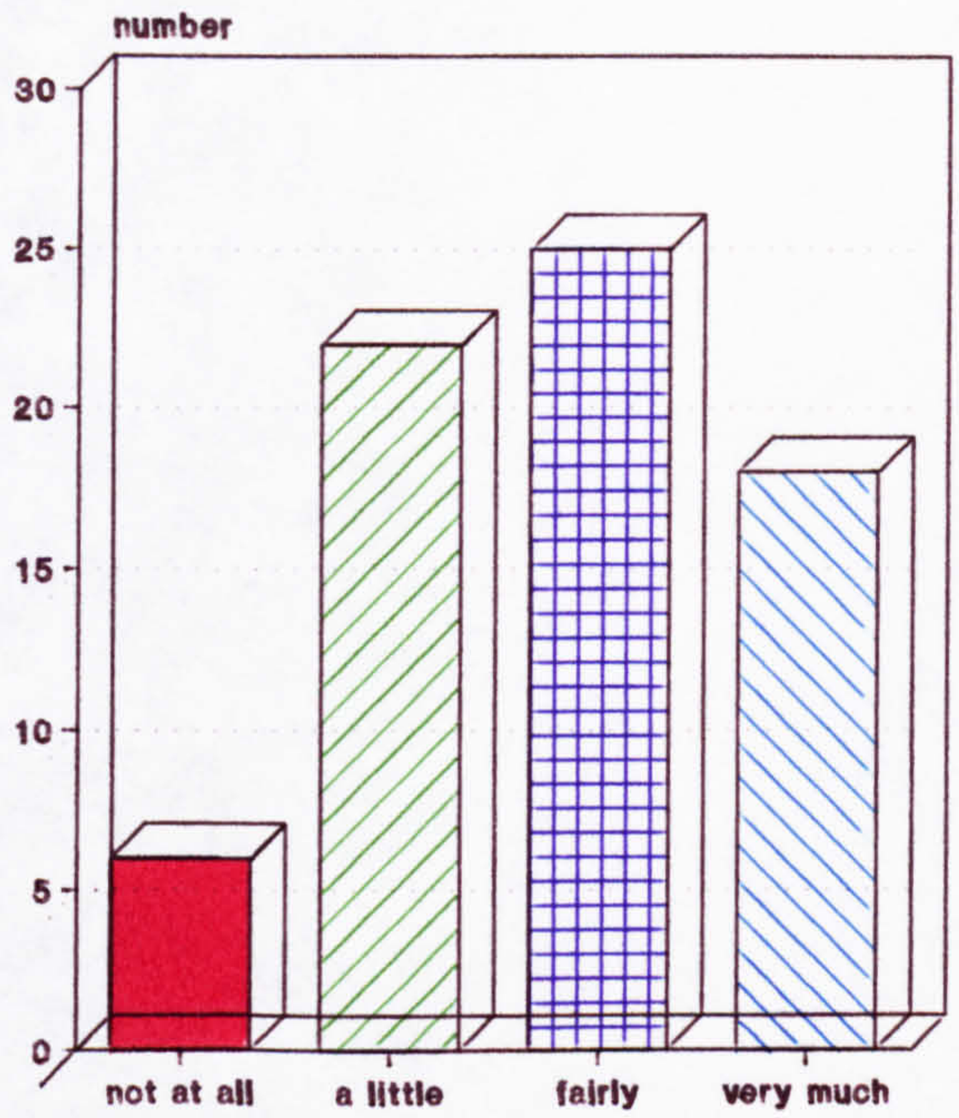

Fig. 7.1 : the degree of annoyance amongst the teachers

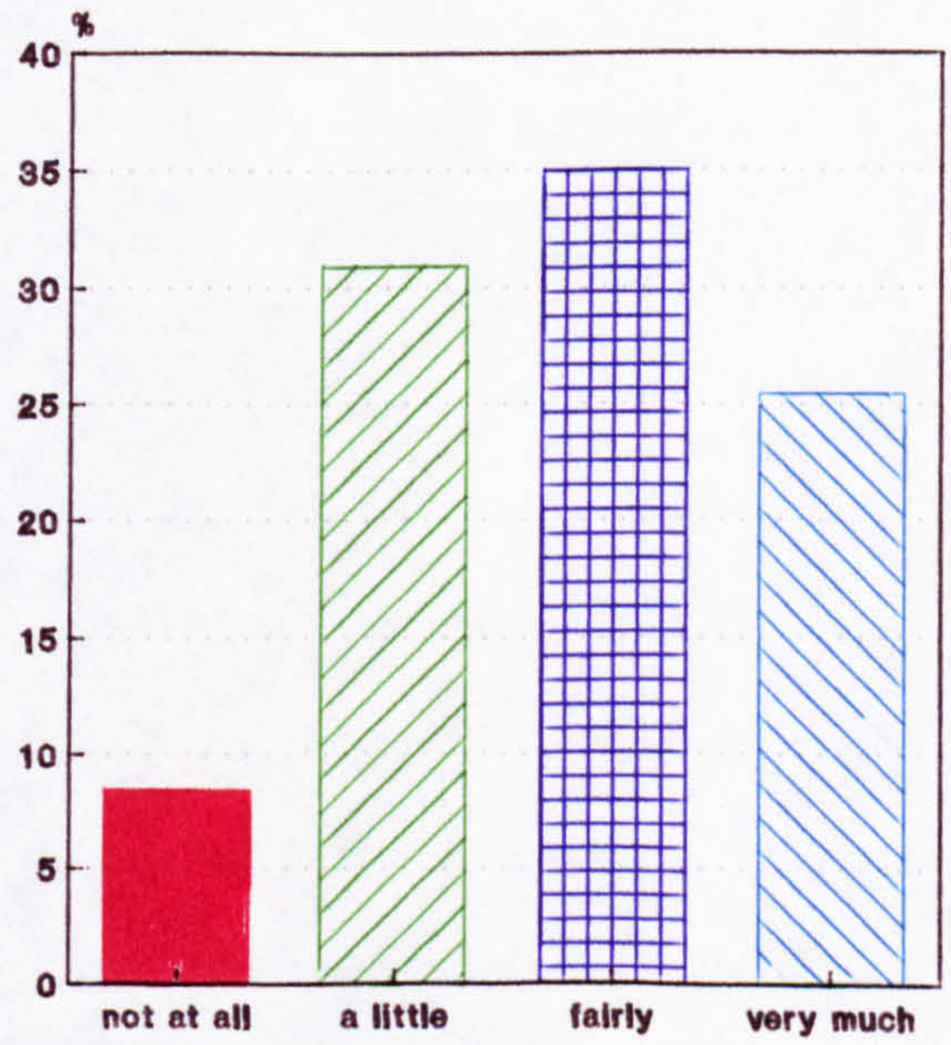

Fig.7.2 : percentage of annoyed teachers

gender differences to aircraft noise annoyance among the teachers

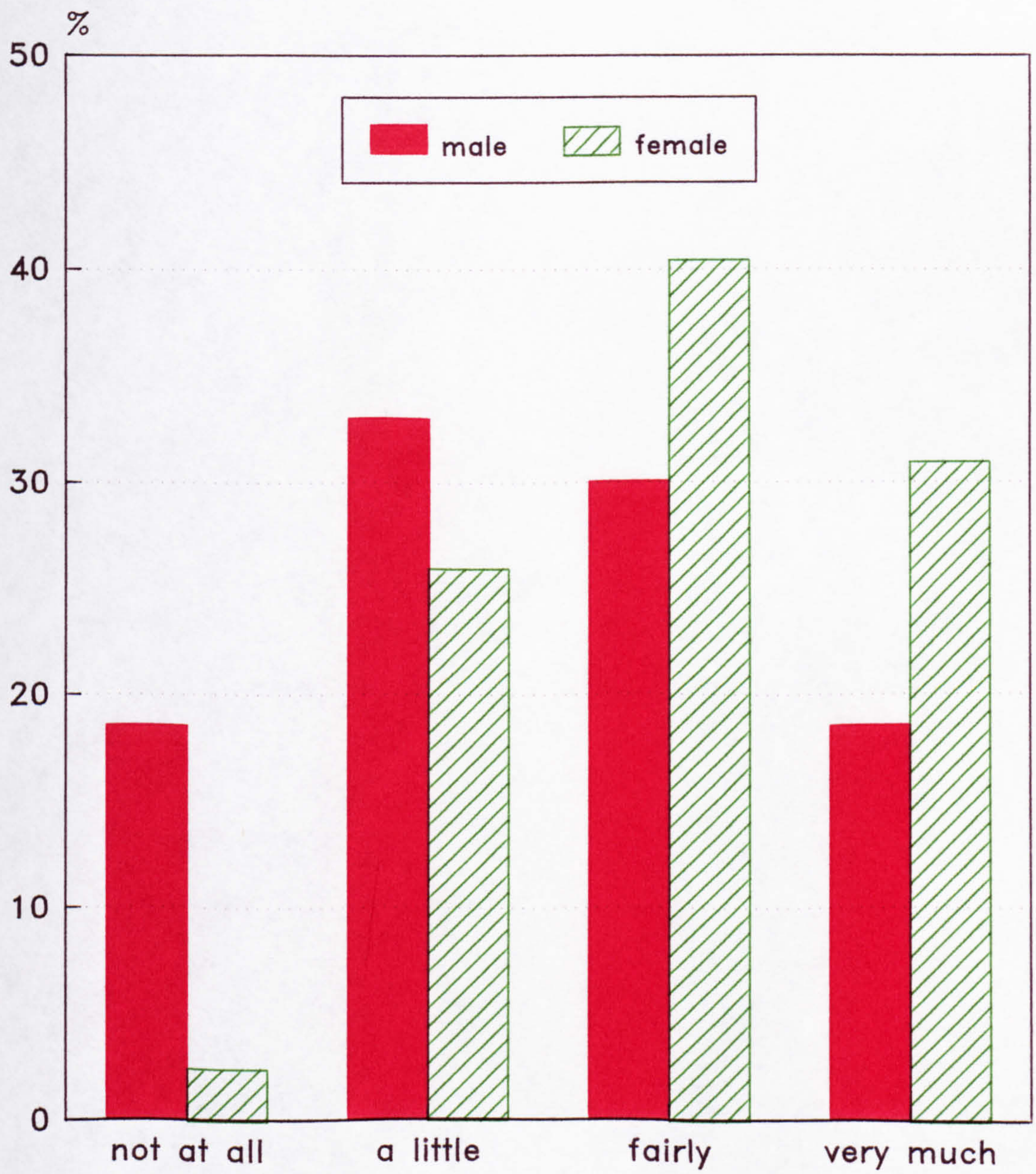

Fig. 7.3.

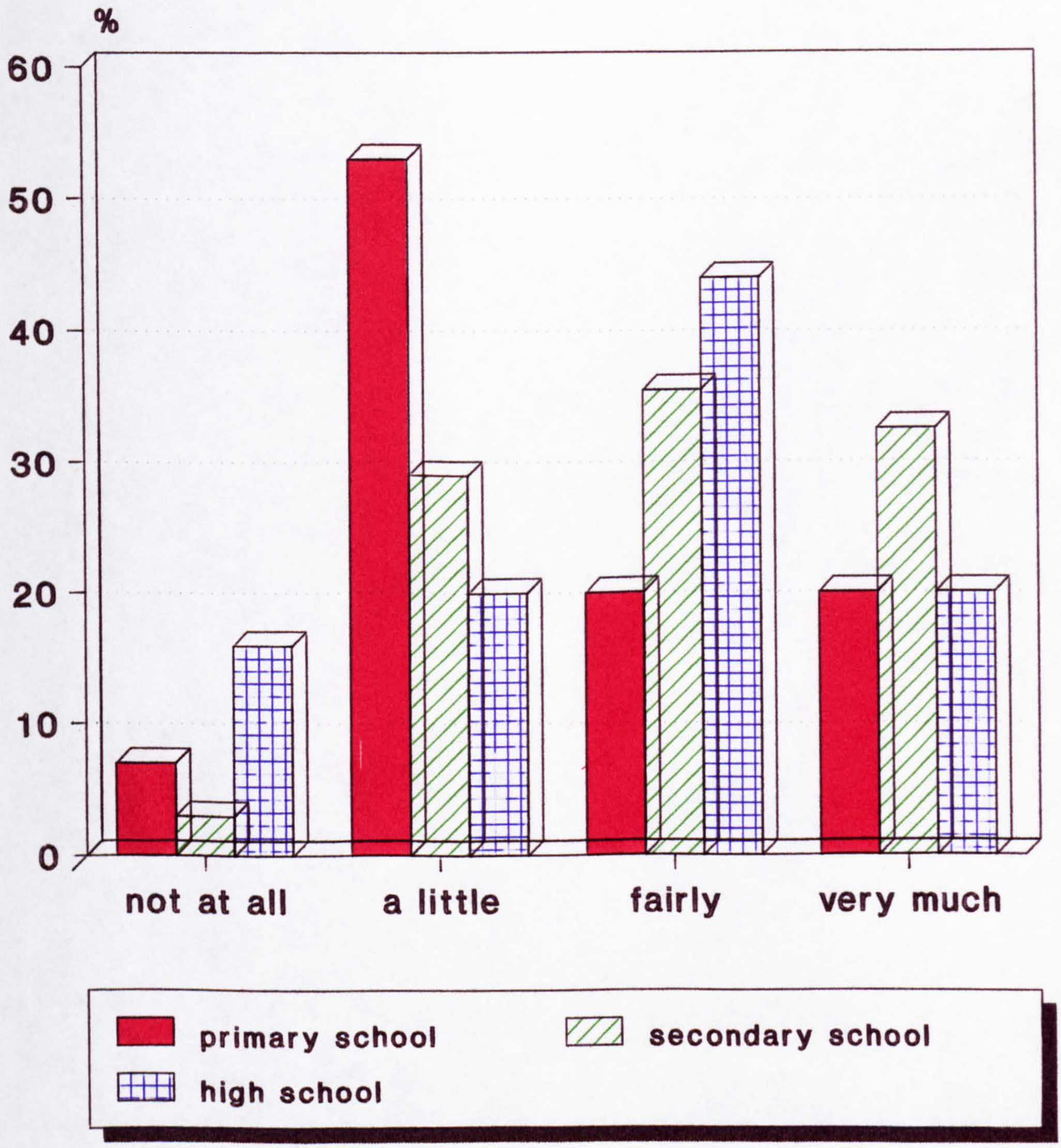
teachers' annoyance to aircraft noise at different grades
%
60
50
40
30
20
10
0
not at all
a little
fairly
very much
primary school
secondary school
high school

Fig. 7.4.

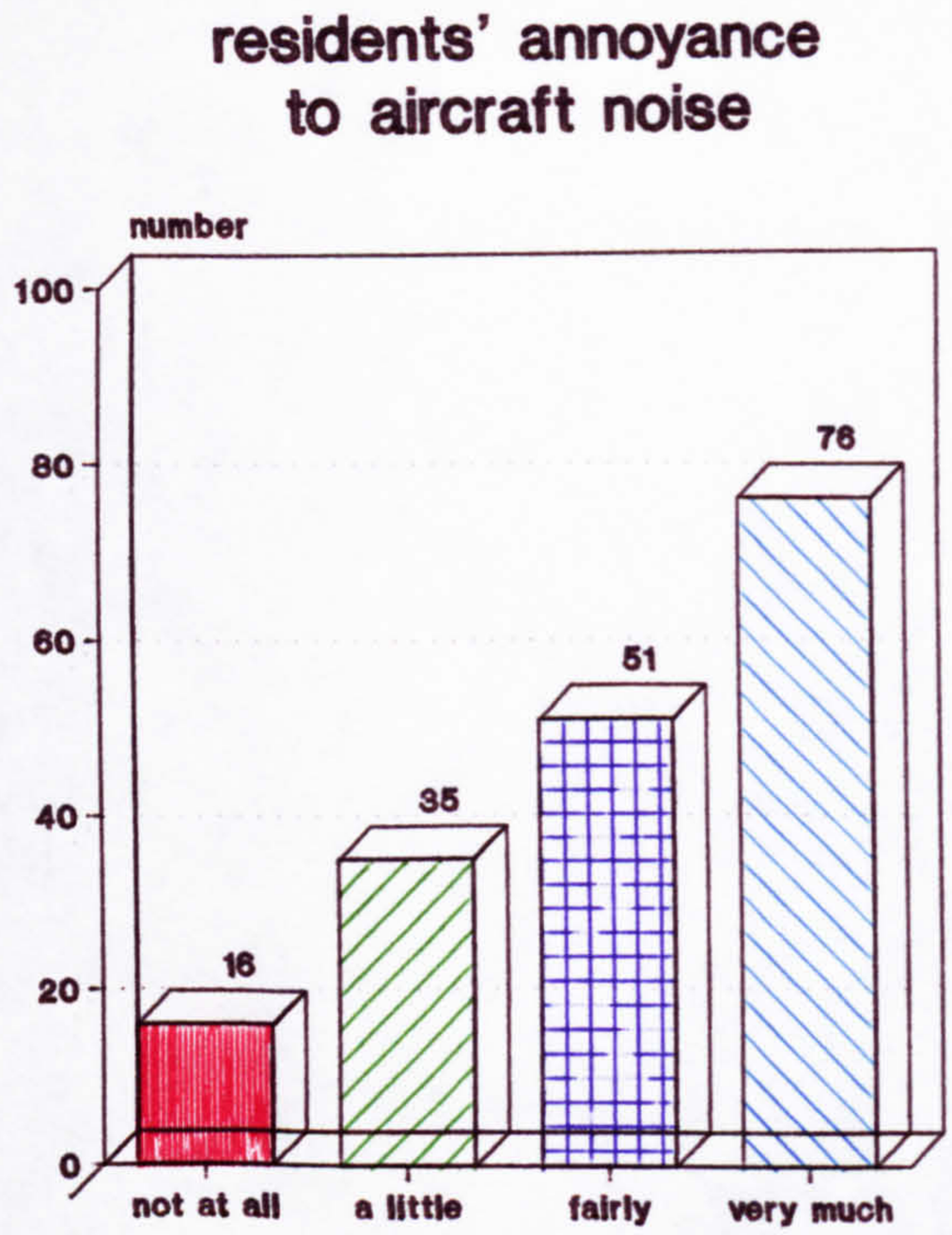
residents' annoyance
to aircraft noise
number
100
80
60
40
20
0
16
35
51
76
not at all
a little
fairly
very much

Fig. 7.5.

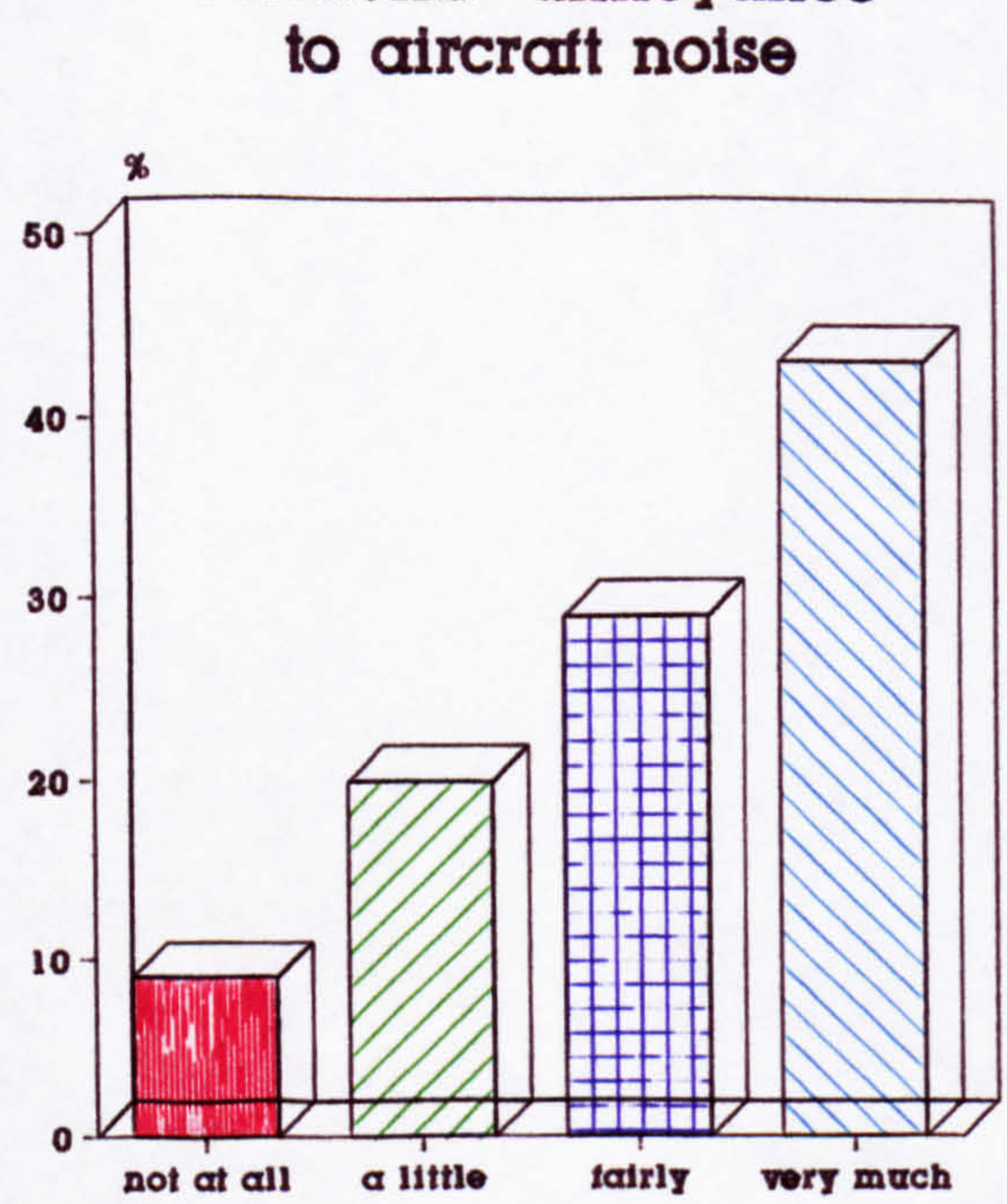
residents' annoyance
to aircraft noise
%
50
40
30
20
10
0
not at all
a little
fairly
very much

Fig.7.6.

There is no evidence of a relationship between the level of aircraft noise problems and the length of time dwelling near Mehrabad Airport. New residents are as annoyed by aircraft noise as long time neighbourhood people (Fig.7.6.1). This confirms other studies (Cohen and Weinstein, 1981). The degree of annoyance amongst the residents with consideration to individual differences shows no differences between single and married residents (Fig. 7.6.2). Highly educated people were more "highly annoyed" than others (Fig.7.6.3) and different occupations gave varied responses (Fig. 7.6.4).

The degree of enjoyment and interest of residents and teachers to aircraft noise showed that 91% of teachers did not enjoy aircraft noise. The women were less enthusiastic about the noise than the men (2% women enjoyed it compared to 19% men). A significant negative association exist between aircraft noise enjoyment and the teaching change rates. Women reported more change whilst teaching (86% versus 63%) when aircraft fly over head. Therefore, changes in teaching could be a cause of less enjoyment amongst female teachers. For residents the enjoyment rated from " not at all " to "very much " 75% of them rated that aircraft noise was not enjoyable (Fig. 7.7). There was no significant gender differences amongst the residents. The different scales ranging from "fairly unsatisfied" to

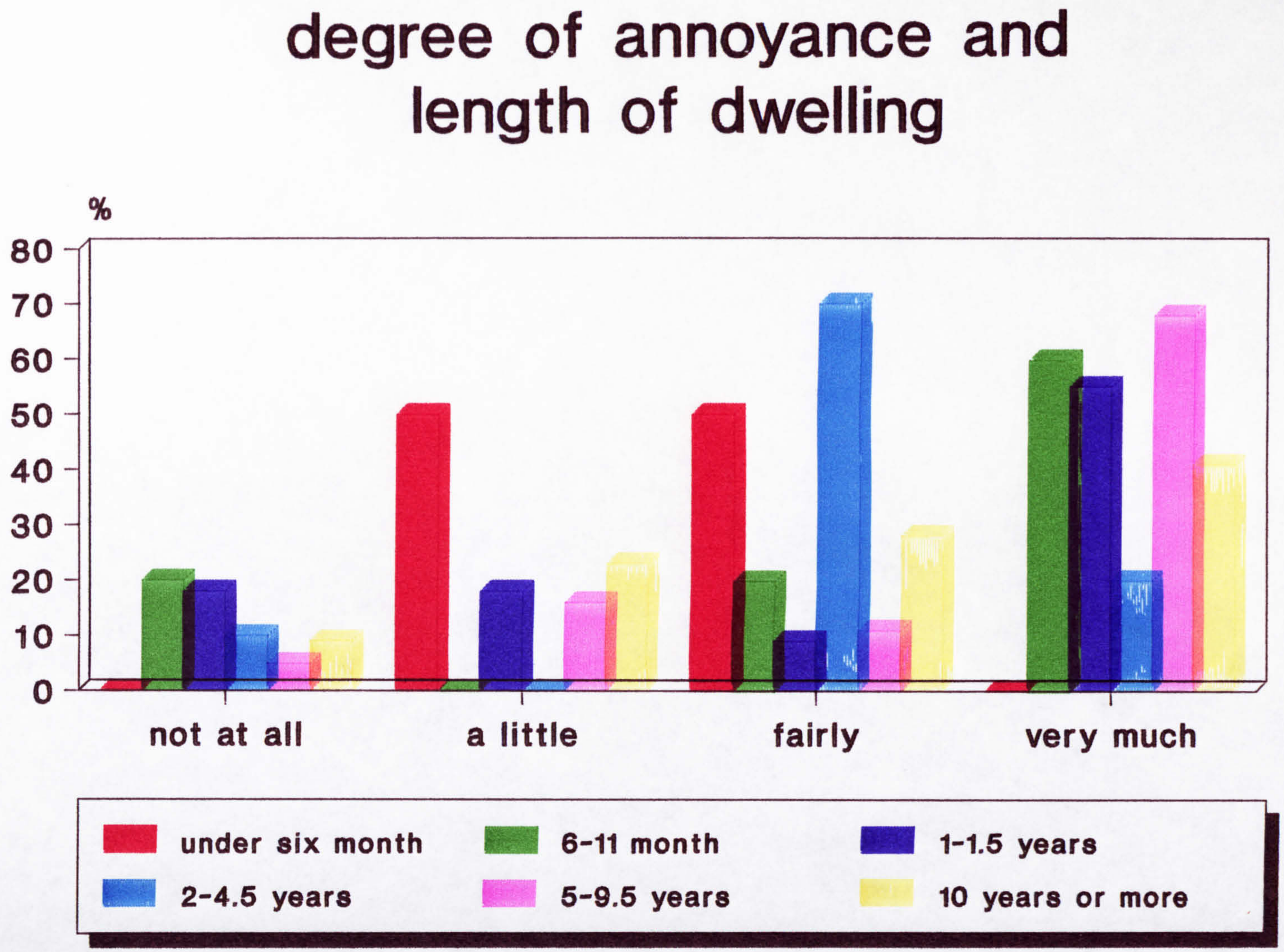

Fig.7.6.1 : residents annoyance and length of dwelling

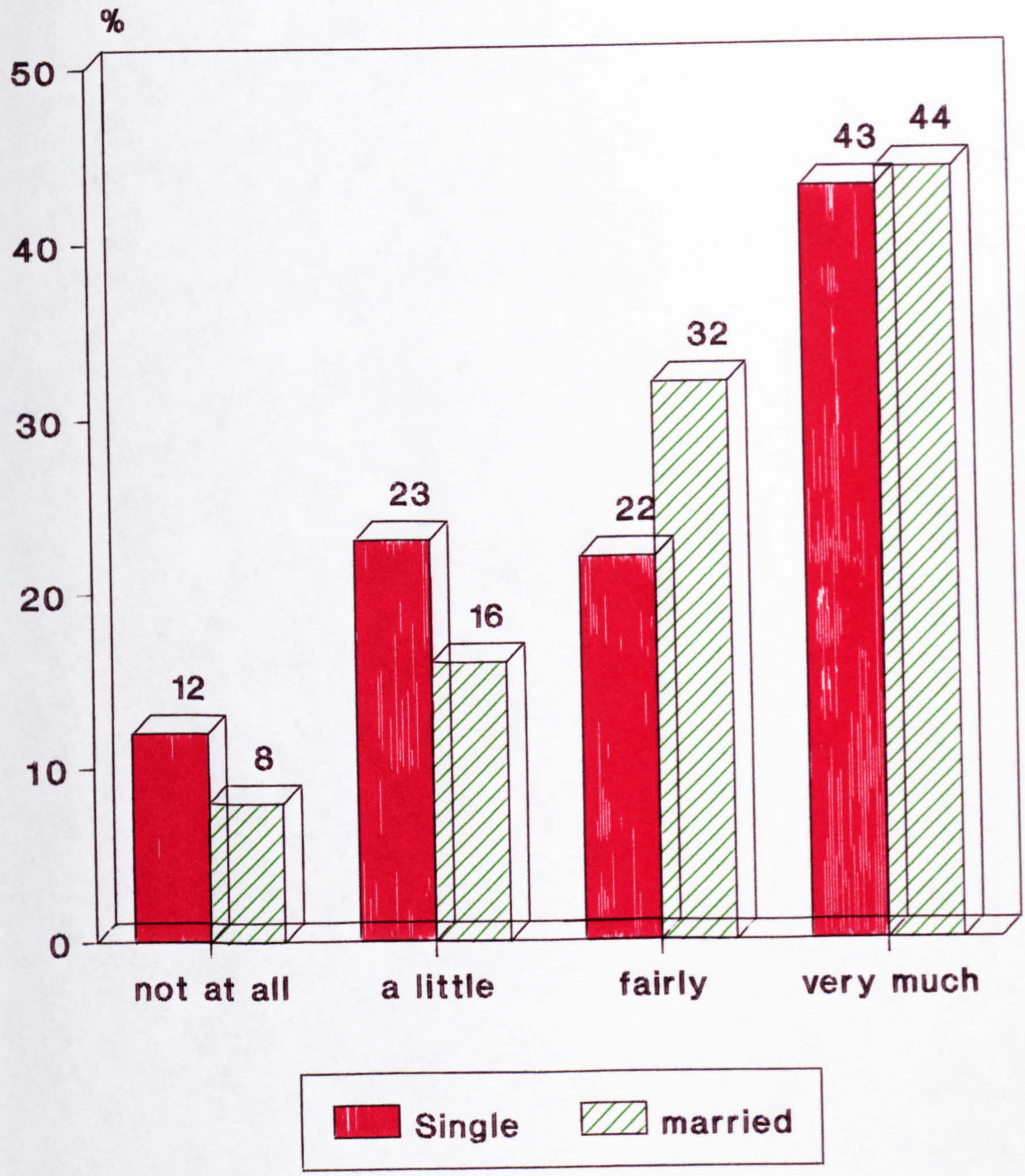
degree of residents'annoyance
(married/single)
%
50
40
30
20
10
0
12
8
23
16
22
32
43
44
not at all
a little
fairly
very much
Single
married

Fig.7.6.2

the degree of annoyance and education level (high annoyed)

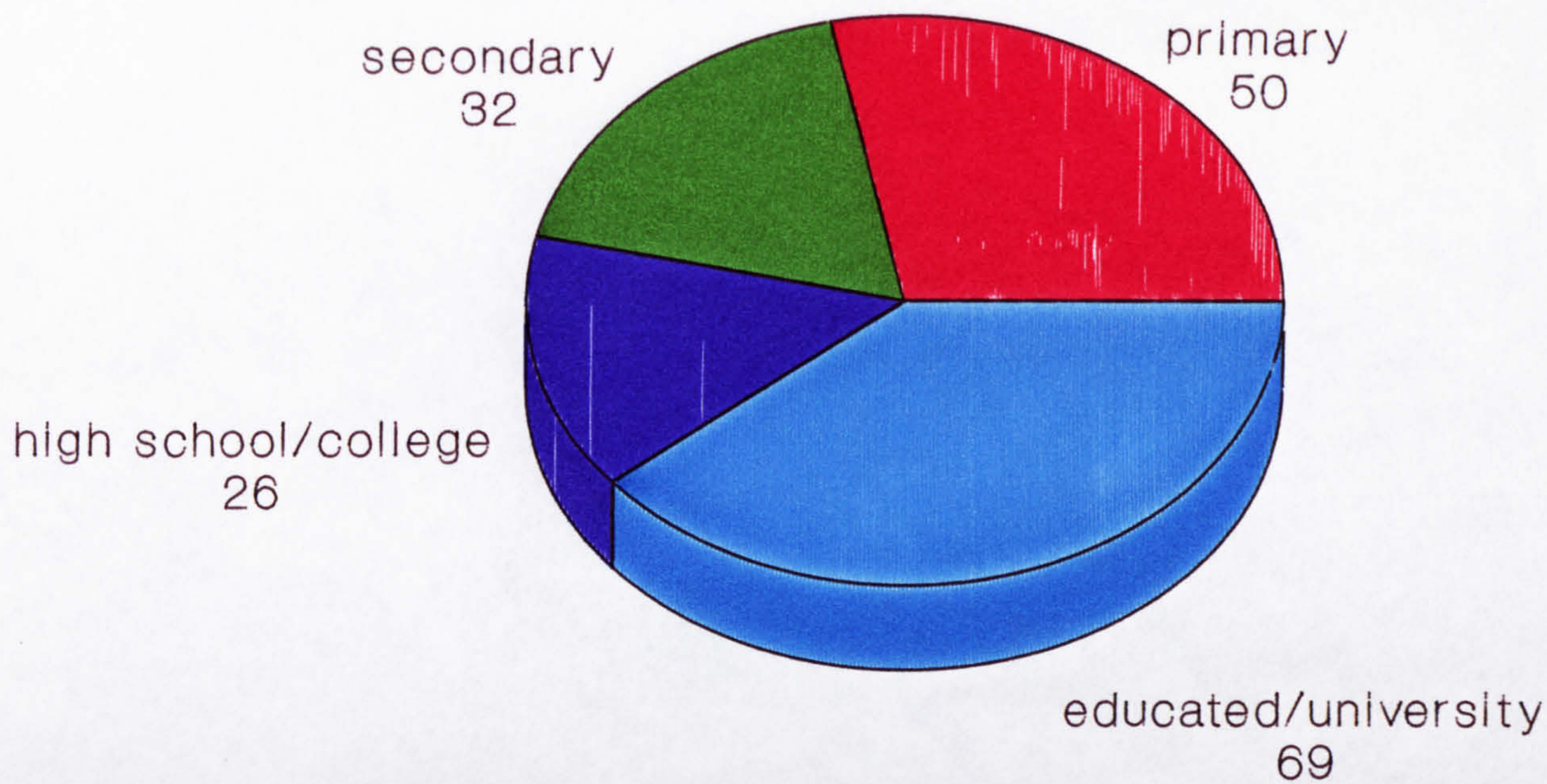

Fig.7.6.3.

degree of annoyance and occupations (high annoyance)

Fig.7.6.4.

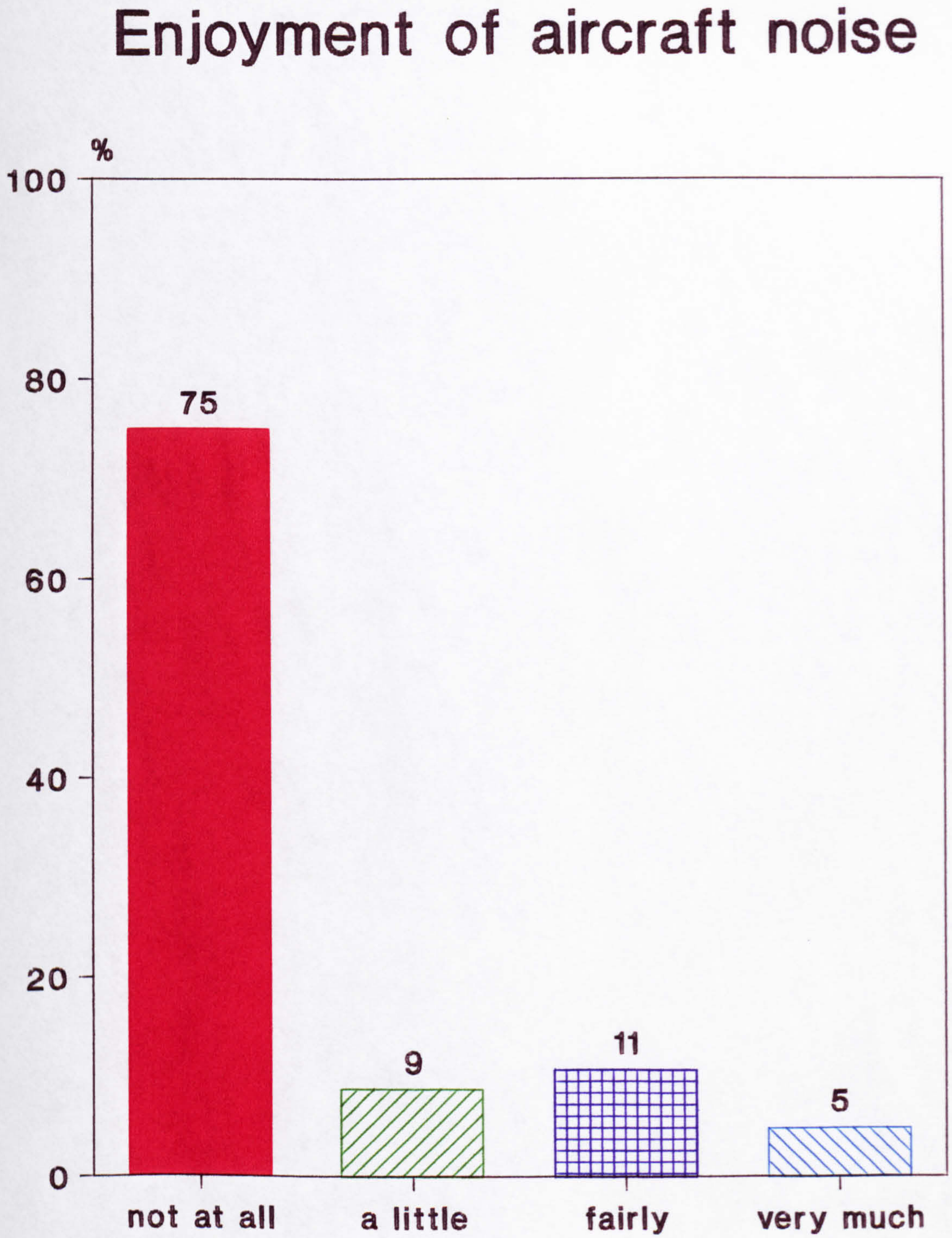

Fig.7.7 : degree of enjoyment(residents)

"definitely satisfied " was used to rate the overall response of the questioned people to aircraft noise. It indicates a relationship between aircraft noise and dissatisfaction scores. The degree to which the noise was assessed and was unbearable to 80% (Fig .7.8) caused dislike of environment amongst residents. Aircraft noise is the most important factor in feelings of dislike for their area (Fig.7.9). Consequently they would like to move from their place due to aircraft noise (fig.7.9.1). Annoyance due to aircraft noise was rated 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 (Fig.7.10) 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 people inside.

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 people also fear the aircraft noise because 68% are not only worried about noise but fear a crash also (Fig.7.11). The results show a significant relationship between the fear of aircraft crashing and the extent of aircraft noise disturbance among the residents. The result was similar for males and females. Fear of aircraft crashing is an

degree of satisfaction

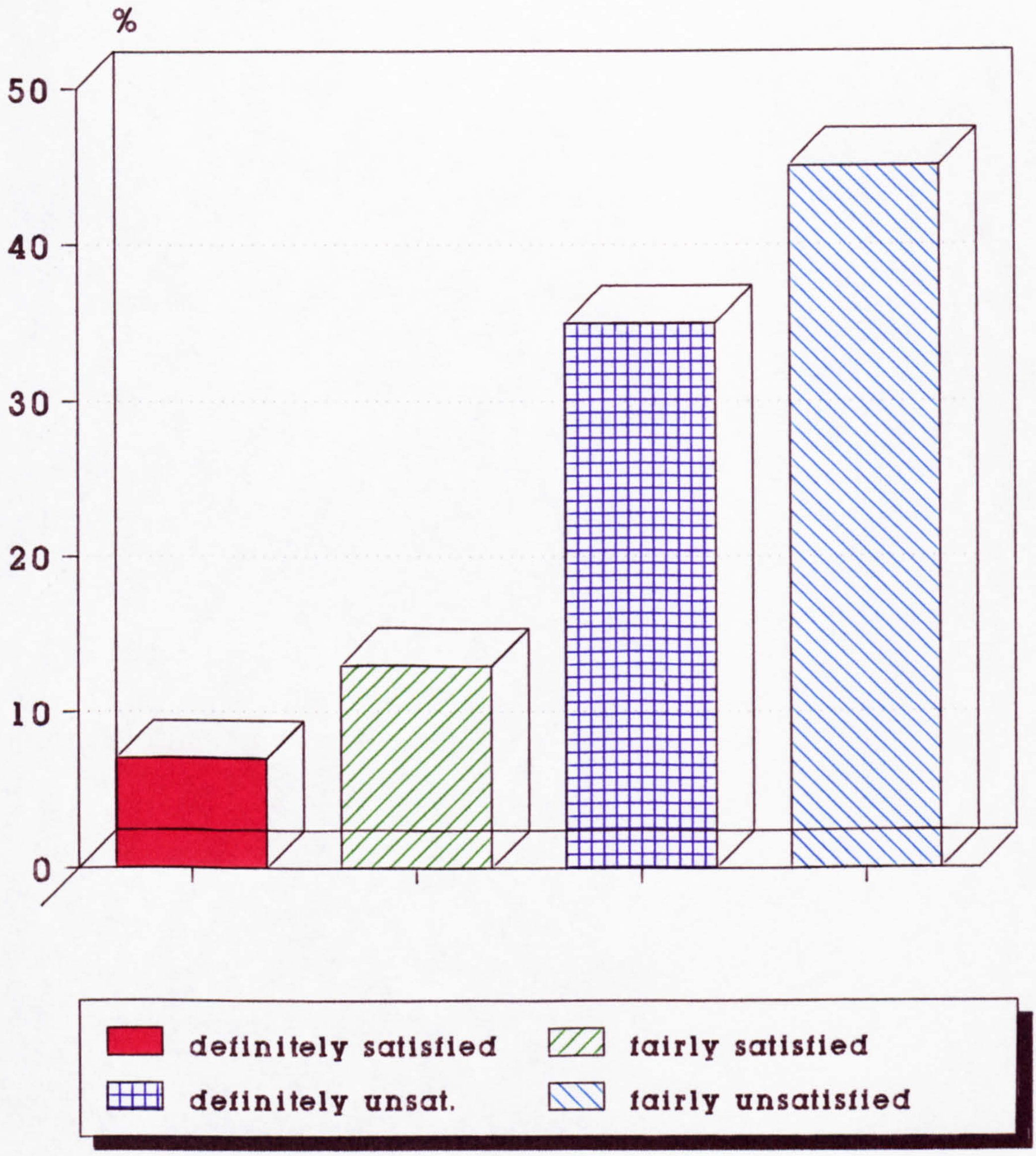

Fig.7.8 : aircraft noise satisfaction

reasons for dislike of area (residents)

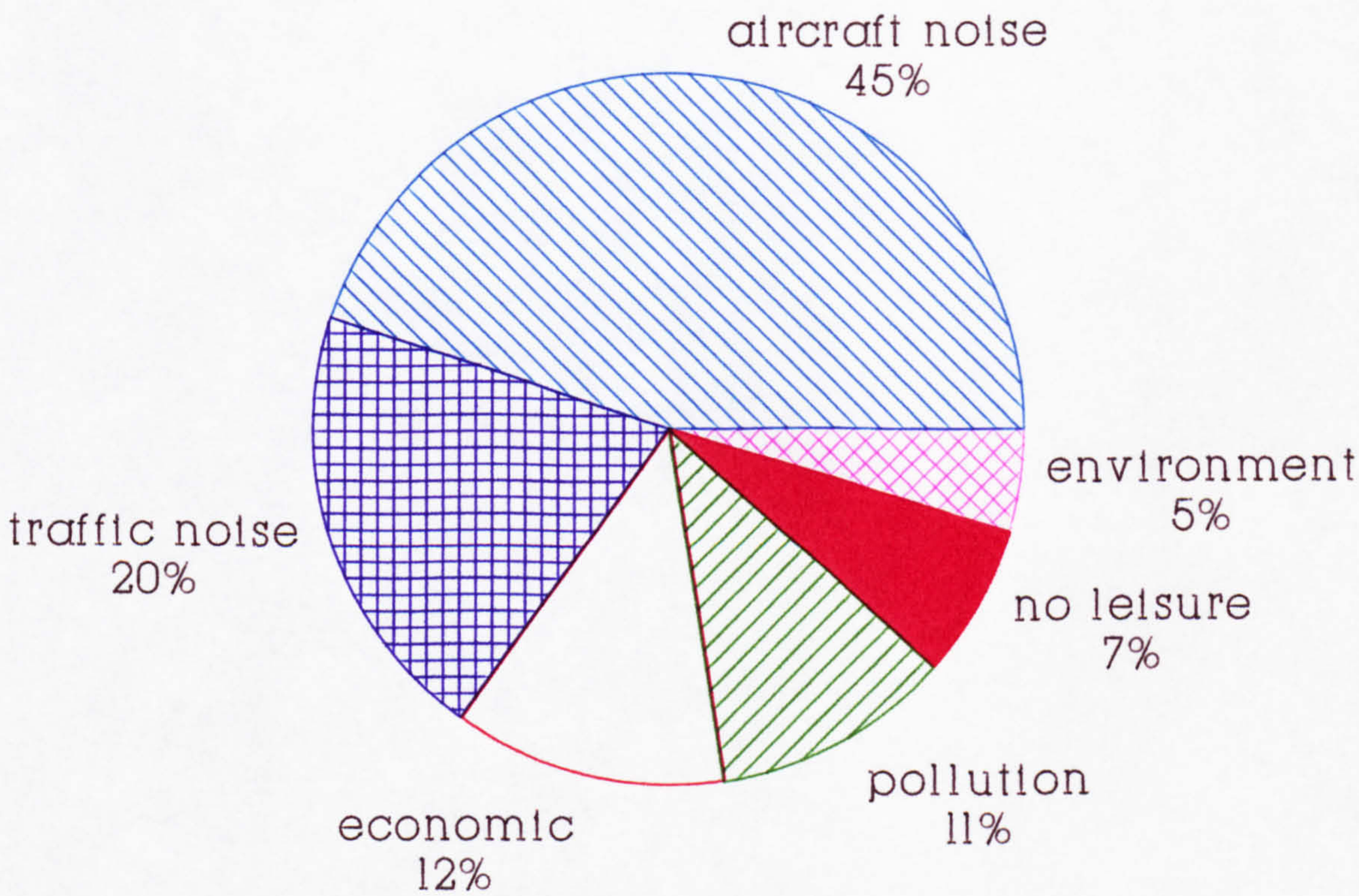

Fig. 7-9. reasons for dislike of area

reasons for "wanting to move"

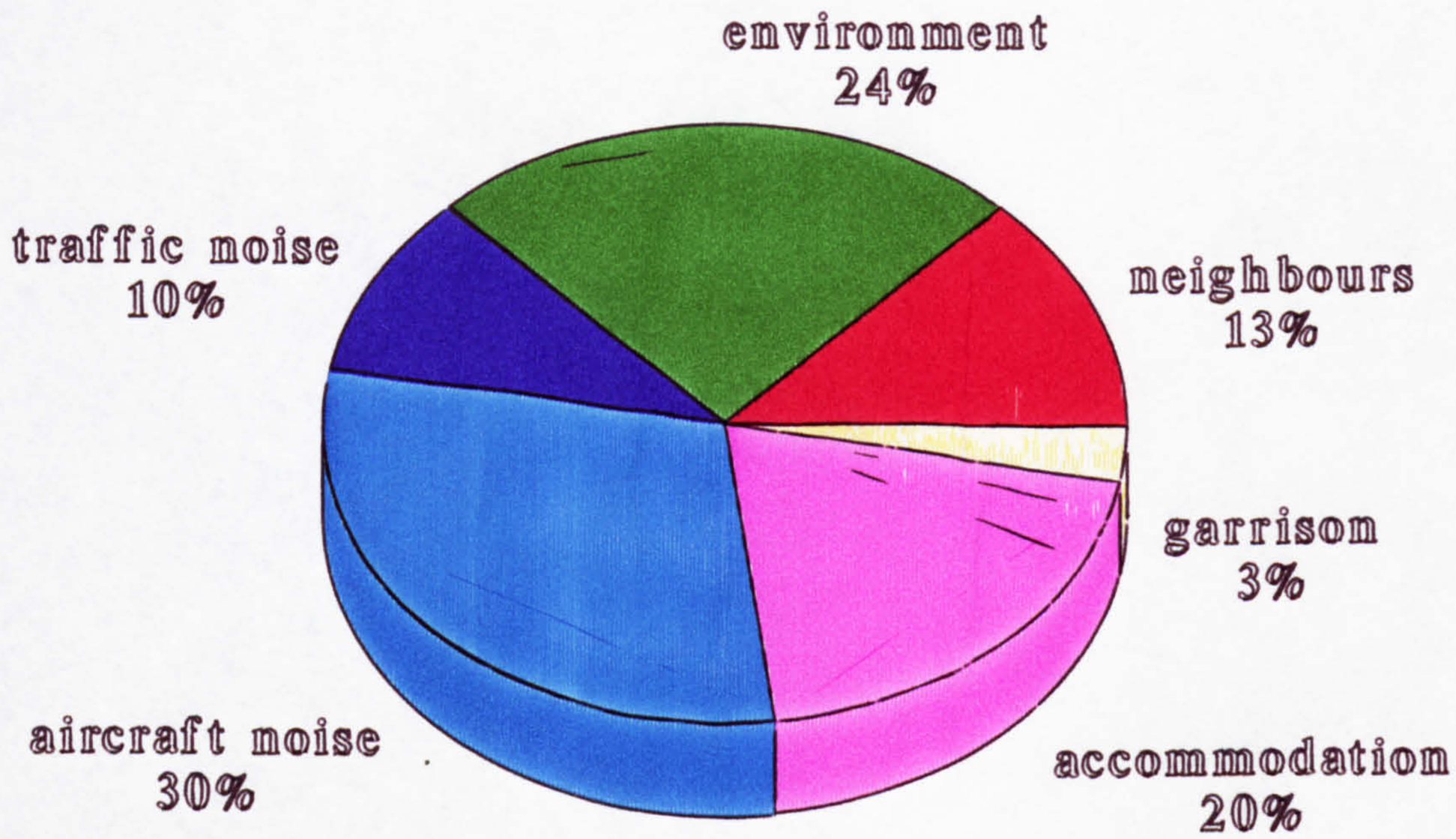

Fig.7.9.1.

noise nuisance
due to neighborhood noises

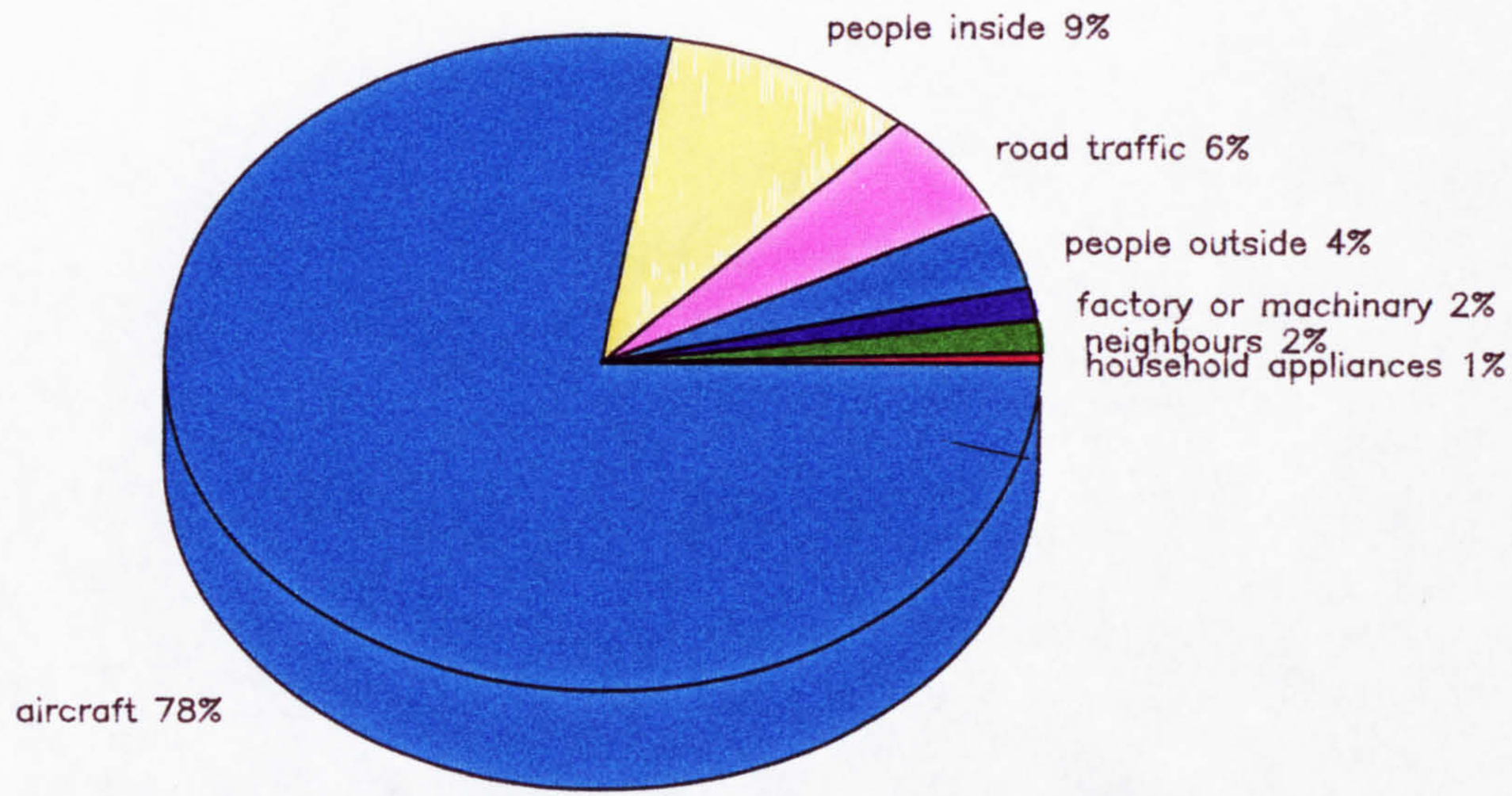

Fig.7.10 :comparison of different noises

fear of aircraft crashing
amongst the residents

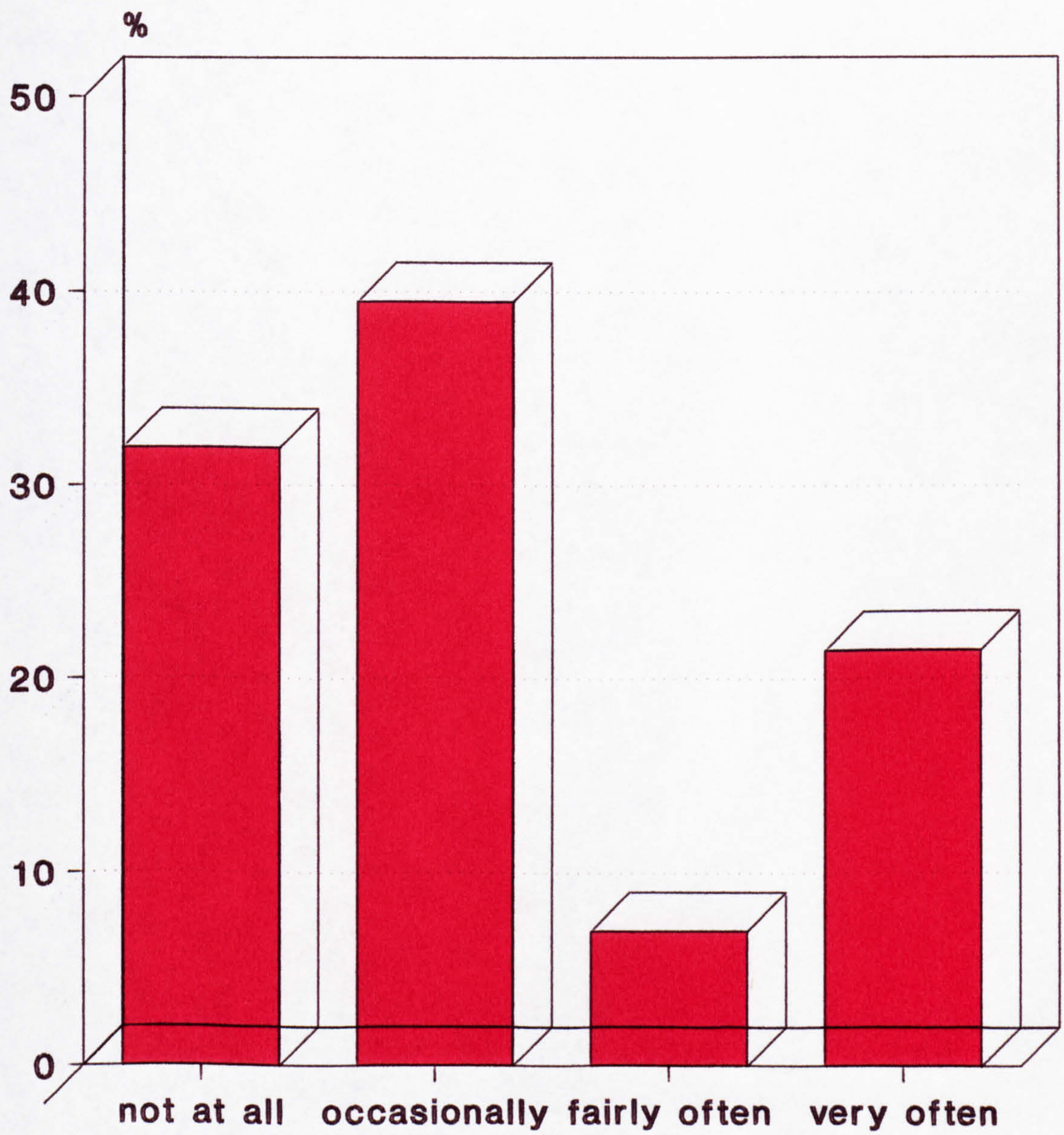

Fig. 7.11 :percentage of fear amongst the residents

important reason for annoyance among the residents and conforms with result of previous studies (Tracor Inc, 1971; Moran, et al., 1980; Stansfeld, et al., 1985; Gunn, 1987).

In the case of children, parents were asked whether or not their children were affected or feared any noise. 85% reported that their children were affected by noise and the majority belonged to those who feared aircraft noise when flights flew over their house (Fig.7.12).

Annoyance is a common psychological response to noise as it is caused by "being bothered" (Mclean and Tarnopolsky, 1977), displeasure with any agent or condition, conversation and rest interference (W.H.O., 1980), fatigue or headache (Stansfeld, et al., 1980). Sleep disturbance by noise is often the underlying reason for noise annoyance (Stream,1980). Therefore, annoyance can be shared between many aircraft noise effects. With consideration to these different indices of annoyance the percentage of people annoyed by aircraft noise (Fig.7.13) indicates that aircraft noise induces different disturbances to prompt "annoyance" .

Comparative analysis of aircraft noise annoyance for British, United State and Iran Airports suggests that a considerable people near airports suffer aircraft noise (Table 8). Comparison of aircraft noise in different areas

children fear
due to different noises

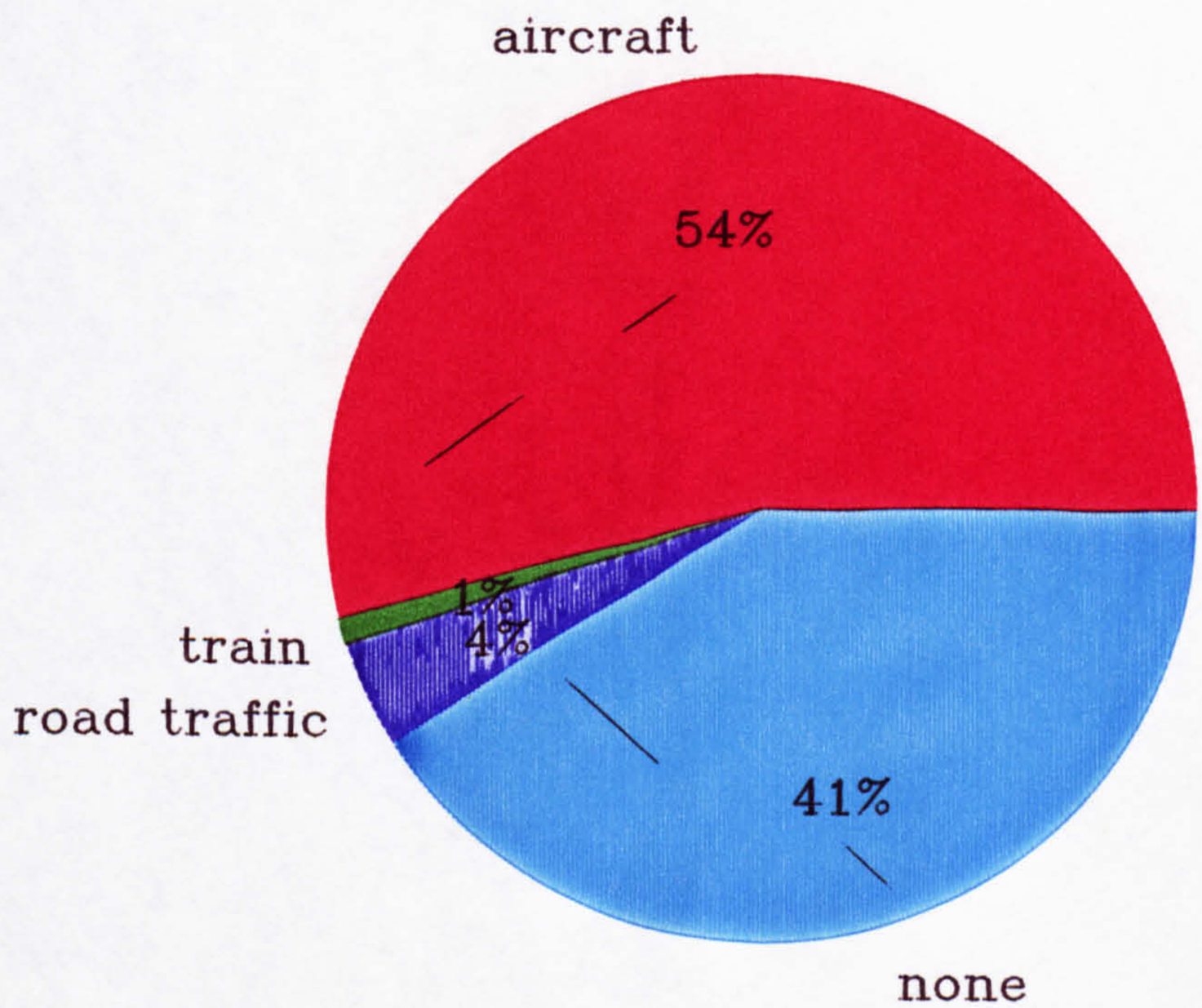

Fig. 7–12 : children fear of noises

different indices of aircraft noise annoyance amongst the residents

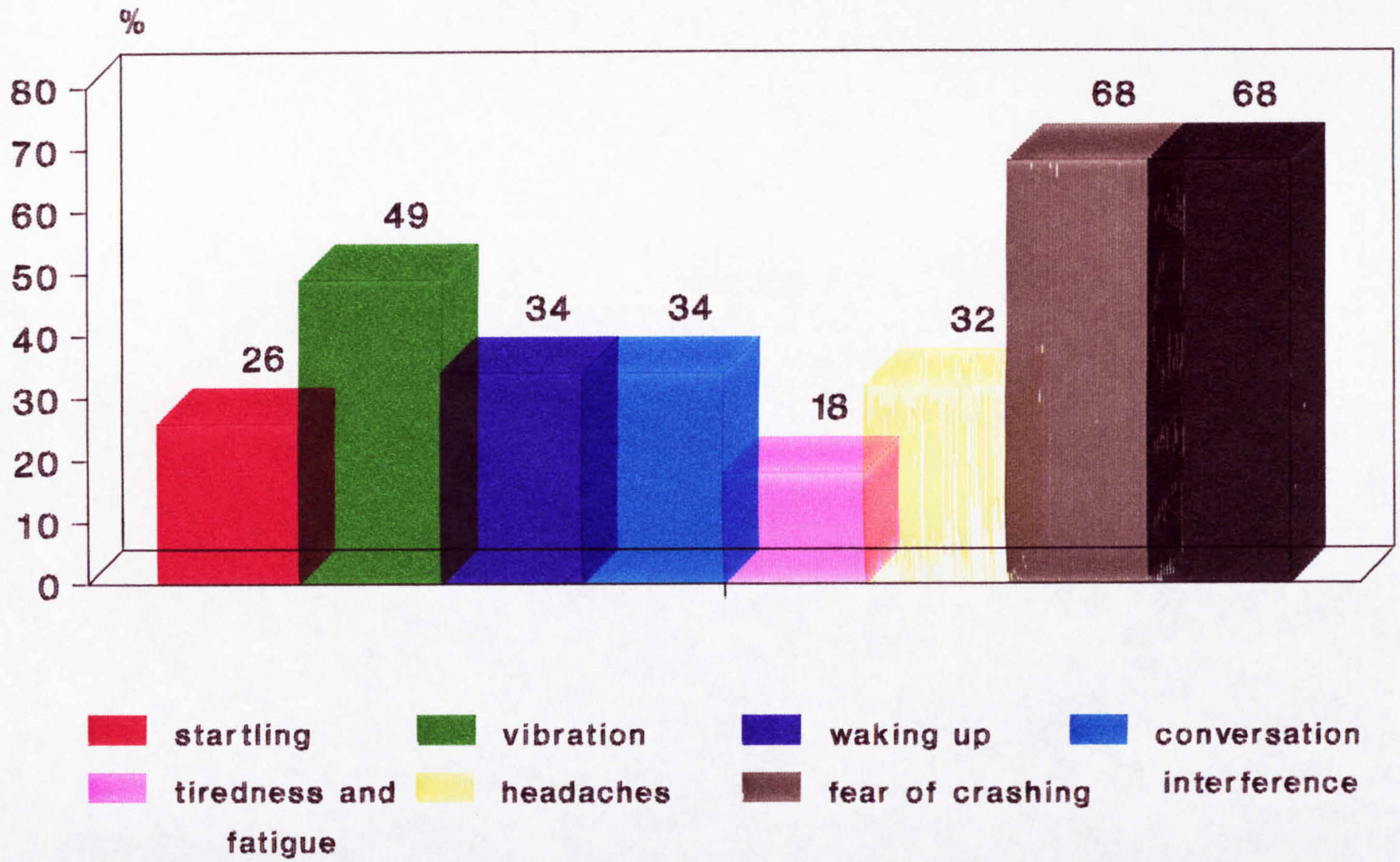

Fig.7.13.

Table 8 : Comparative analysis of aircraft noise annoyance for British United States and Iran Airports (modified on Bugliarello, et al., 1976).

Disturbance	London	Chicago	Los Angles	Denver	Dallas	Tehran
	Percent annoyed					
House vibration	16	44	60	31	49	49
T.V./radio reception	28	56	68	36	52	45
Face to face conversation	41	51	66	37	40	34
Sleeping	57	24	35	19	22	44
General aircraft annoyance	86	65	80	49	67	91
Percent not annoyed	14	35	20	51	33	9

suggests the higher noise level contributes most to annoyance (Fig. 7.14). High noise levels induce different indices of annoyance and people are more startled and their sleep was more disturbed in more noisy situations (Table 7). In the case of teachers there were only minor and inconsistent differences of problems in studied areas (Table 9). Teaching interference due to aircraft noise is a significant consequence to lead the teachers around Mehrabad Airport to complain of headaches and tiredness. On the other hand, tiredness and headaches are significant factors which cause teachers to feel more annoyed, dissatisfied and want to change their teaching place. Therefore, communication interference is a strong reason for feeling annoyed.

People are aware of the noise effect on their health (95% of them rated that noise threatens health). Over 78% believe that aircraft noise threatens health "fairly" or "very much" (Fig.7.15). Better educated residents are more worried about health effects of aircraft noise (Fig. 7.15.1). A significant relationship between the extent of annoyance and perception of aircraft noise danger shows that if noise is judged as being harmful, the level of annoyance will be determined. It confirms previous studies (Cohen and Weinstein, 1981; Levy-leboyer and Naturel, 1991), that indicated the importance of respondents' perception to noise .

Noise level and annoyance

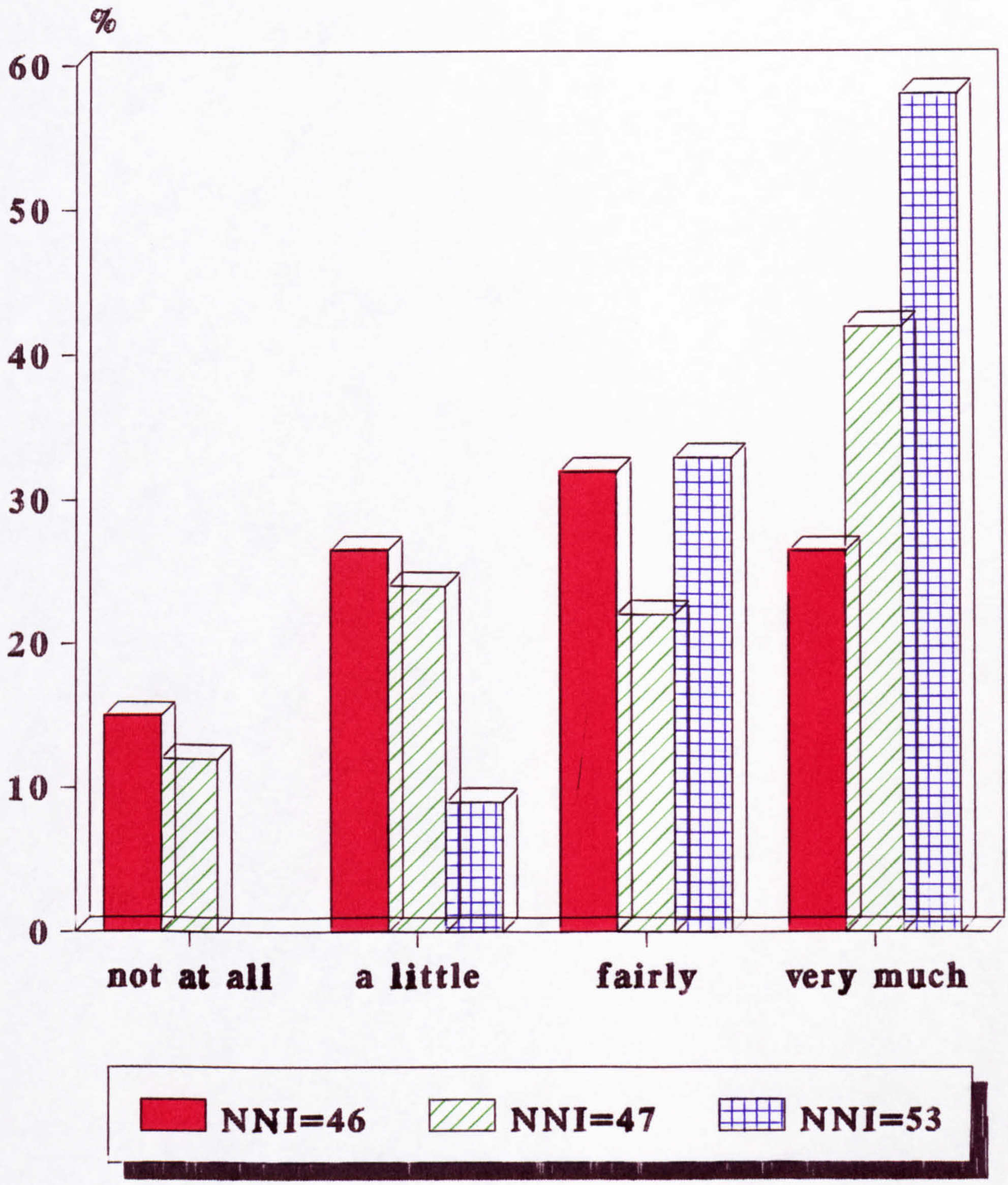

Fig. 7.14.

Table 9 : Percentages of teachers' disturbances at studied areas (different noise level).

Disturbances	NNI=56 (area 1)	NNI=47 (area 2)
Abandon lessons	80	75
Performance	49	63
Changes whilst teaching	84	56
Speech interference	58	80
Teaching interference	62	60
Stop teaching	86	83
Close windows	24	33
Forget subjects	6	-
Alter the way of teaching	4	-
Pupil become noisier	21	20

perception of residents to aircraft noise problems

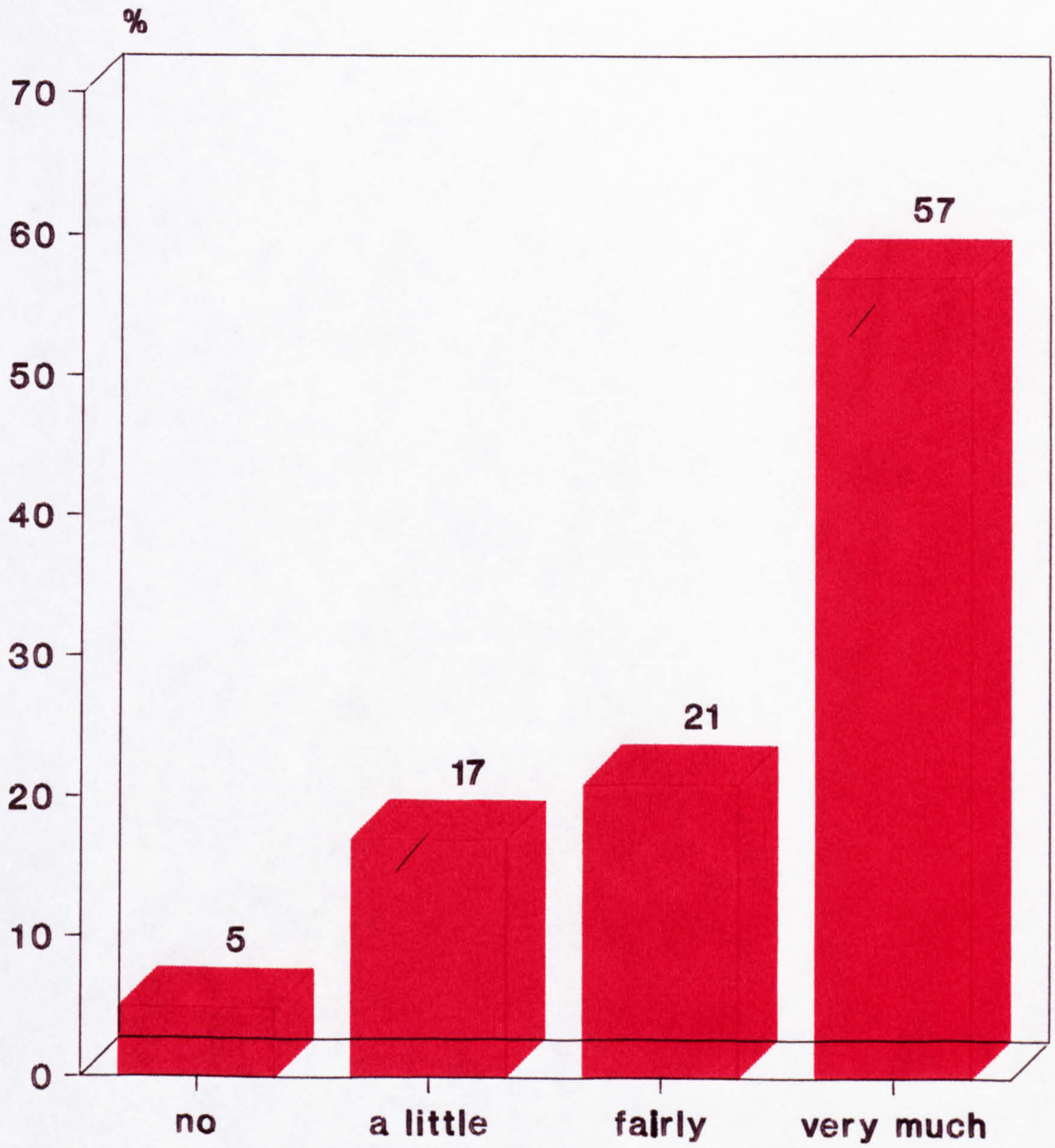

Fig 7.15.

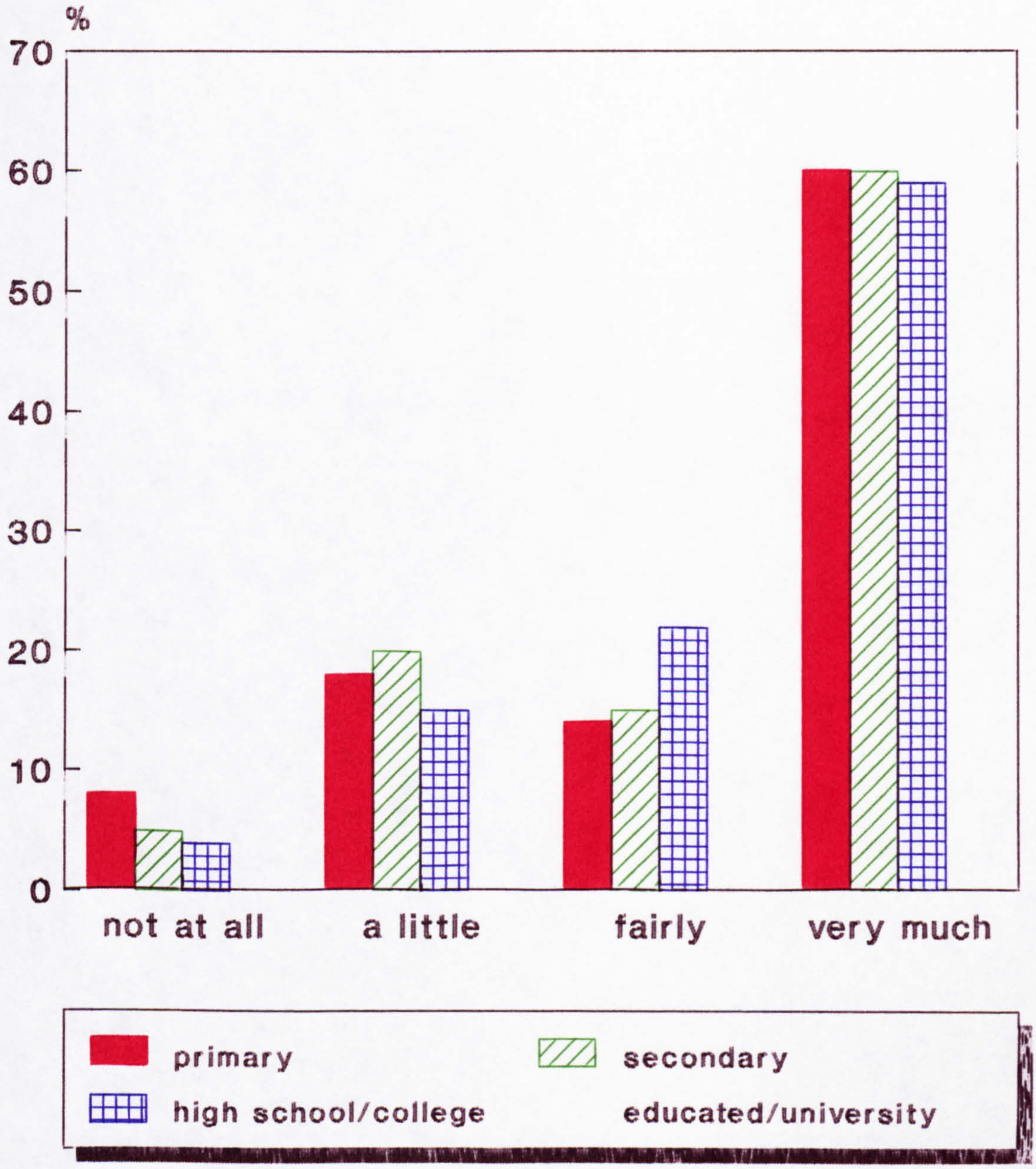
perception to health effects of aircraft noise and education level
%
70
60
50
40
30
20
10
0
not at all
a little
fairly
very much
primary
secondary
high school/college
educated/university

Fig.7.15.1.

To highlight noise sensitivity, residents were asked " do you think you are more or less sensitive than others to the noise " . Subjects were classified as high noise sensitive if they reported more and low sensitive if they said less (Figure 7.16). Women reported being more sensitive to noise than men (Fig.7.17), but there was no significant differences between reported noise sensitivity and the extent of annoyance.

residents self reported noise sensitivity

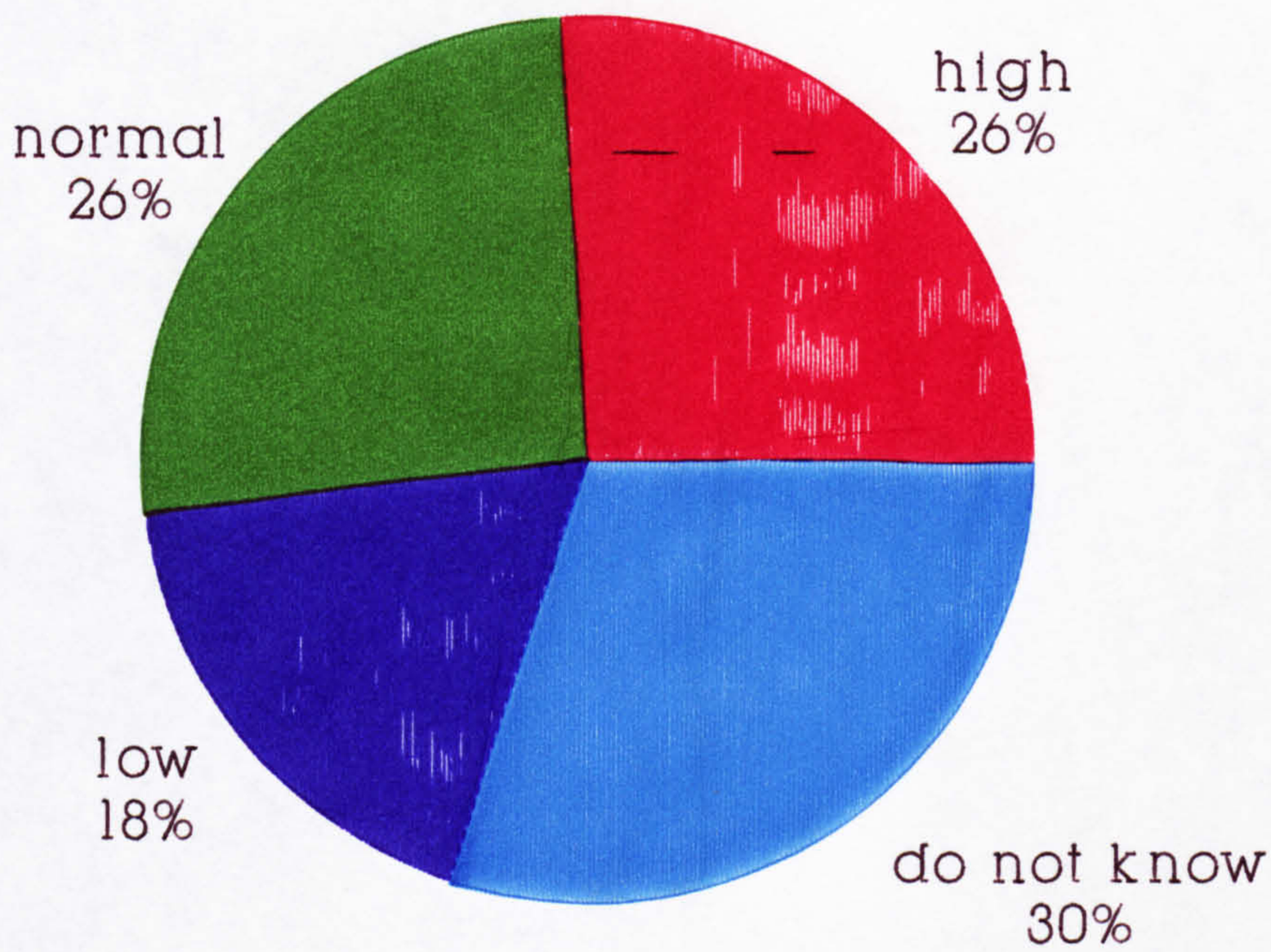

Fig. 7.16 : degree of sensitivity

gender differences to noise sensitivity

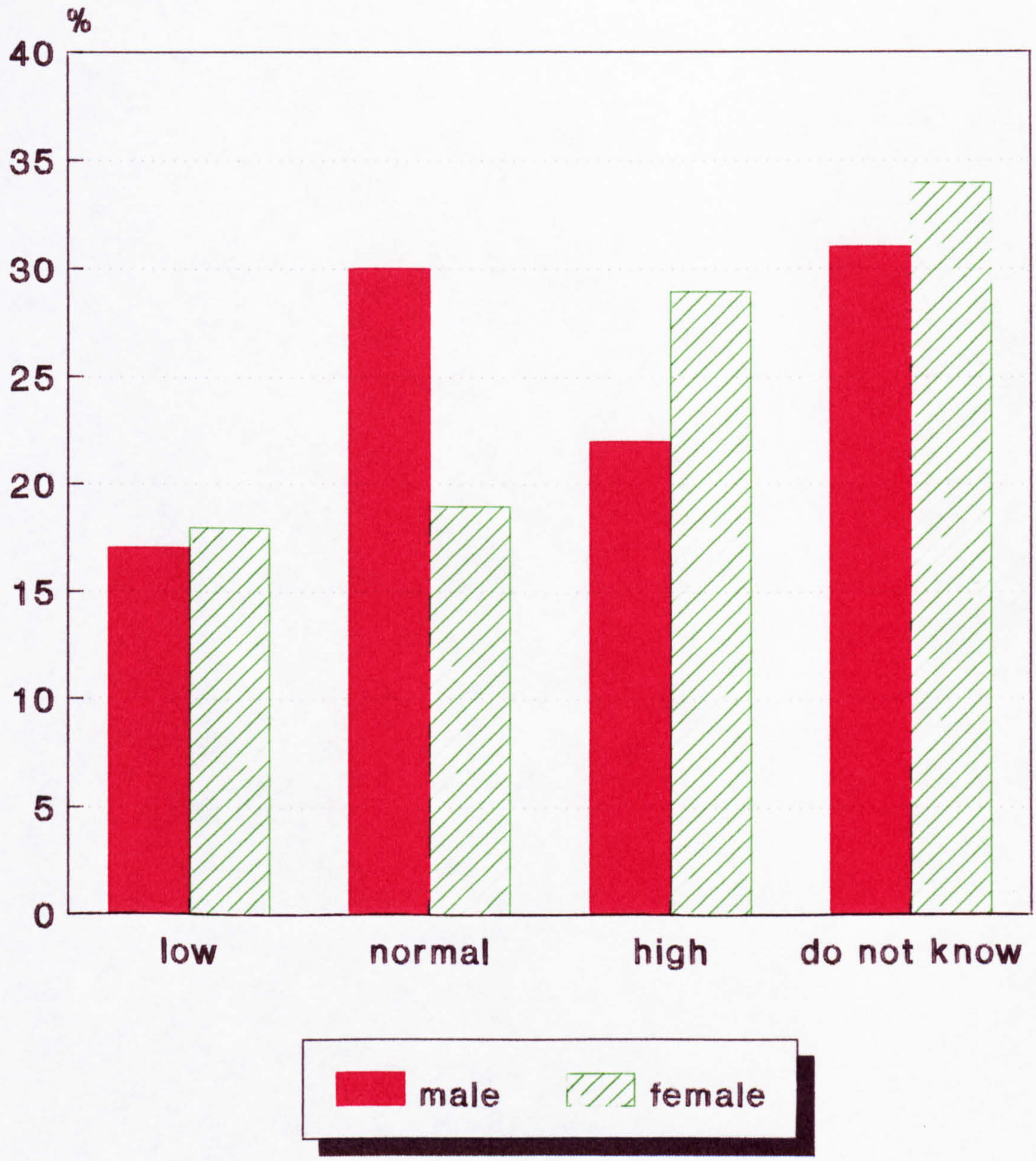

Fig. 7.17 : self reported noise sensitivity

CHAPTER VIII NOISE AND MENTAL HEALTH

CHAPTER VIII

NOISE AND MENTAL HEALTH

The psychological, physiological and behavioral aspects are clearly linked to each other (Kagan, 1980). However, these aspects will be divided into psychological, psychophysiological and psychiatric disorders.

1- Psychological effects of noise

Increased attention in the 1960s and early 1970s to noise as a social problem stimulated the initial interest of social psychologists (Cohen and Spacepan, 1984). Even after half a century of research on the human health effects of noise, we still do not fully understand the psychological effects of noise (Broadbent, 1980). However, many successful experiments have been devised to explain this aspect and no doubt we are better equipped now to reveal the mysteries of noise.

It is common knowledge that noise can irritate and annoy, and it is also common usage to say that "noise is driving me crazy" (Mclean and Tarnopolsky, 1977).

The importance of noise pollution is in no way less than air pollution. It generates a social danger comparable to the other well documented hazards such as chemicals.

Noise is probably the most widespread problem in the physical work environment and it is also one of the environmental problems for which the psychological view points are obviously important (Kjellberg, 1990). Noise is the most influential factor that causes permanent nervous stress (Krichagin, 1978). Different investigators have attempted to study this dimension and surveys have shown that noise exposure can generate many psychological problems. However, an environment without some arousing sound causing stimulation, would be undesirable (Kryter, 1980). Laboratory tests on animals have also shown that total quietness is not a desirable condition for them (W.H.O., 1980).

The psychological stress of exposure to industrial noise includes job dissatisfaction, complaints, irritability and anxiety (Melamed, et al., 1988). These confirm earlier studies by Clark (1984). Industrial noise could be a source of fatigue (Mckennel, 1988) though Kryter (1980) argued that only noise and not the sound would be stressful.

Studies by Klitzman and Stellman (1989) on office workers show that physical characteristics of the office environment can have an impact of psychological well-being. They suggested, as earlier studies had shown, that noise was the chief complaint among office workers. In this study, noise was also one of the strongest correlates of

psychological well-being. It is known that aircraft noise can diminish mental capacity and causes feelings of alienation and anxiety for many people (Knipschild, 1977 VIII). Surveys (Mclean and Tarnopolsky, 1977; Tarnopolsky, 1978; Dejoy, 1984) showed noise induced a higher proportion of psychological and psychosomatic complaints leading to the consumption of sleeping pills, sedatives or tranquilizers with increased incidence of visit to the physician. High levels of noise cause irritability, tenseness, insomnia, tiredness and fatigue, nausea, instability, anxiety, argumentativeness, sexual impotence, nervousness, abnormal somnolence, loss of appetite, and lowering and changing of spirit and mood (W.H.O., 1980; Mclean and Tarnopolsky, 1977; Cohen and Weinstein, 1981; Bugliarllo, et al., 1976 and Malerbi, 1989).

Residents around Orly Airport Paris with 400 landings, and take offs per day (but no flight between 11 pm and 6 am), had average degrees of anxiety, neuroticism and extraversion which are unaffected by the aircraft noise level even among respondents exposed to a loud noise (Franclos, 1980). Respondents reported more fatigue and bodily pain and their health was poor during the month before the survey. Ohrstrom and Bjorkman (1978) showed that fatigue and headache increases with higher noise level and longer periods of exposure to the machine and textile industry . Although other studies suggested no increase in fatigue due to working in noisy industrial premises,

fatigue and its effect on performance could be the direct effect of noise or indirect through interference with sleep (W.H.O., 1980).

Noise reduces tolerance for frustration, reduces level of aspiration, regulates effort and influences the perception of competence (Smith, 1989). There is evidence that helping behaviour reduces in noisy environments. Exposure to 85 *dB(A)* produced less help to others than those exposed to 65 dB or lower noise levels (Cohen and Weinstein, 1981). However, exposure to unpredictable and uncontrollable noise will decrease helping responses (Cohen and Spacepan, 1984). Noise seems to be responsible for decrease in the tendency to grant even small favours and reduced sensitivity to others, in noisy condition (Cohen and Weinstein, 1981) . In three streets of San Francisco it was found that people on the noisy street reported that the street was a rather lonely place to live, compared to people on light traffic streets who reported the street as a rather friendly, sociable area (Appleyard and Lintell, 1972 quoted by Cohen and Weinstein, 1981).

An increase in social conflicts in noisy areas at home and in the work place was reported by Jansen (1961). It is important to note that suicide rates as a direct effect of noise disturbance (Bugliarello, et al., 1976). A study using data from 1970-1980 conducted around Los Angeles Airport (LAX) by Meecham and Shaw (1988) showed a

significant relationship between aircraft noise and suicide. Over 100% increase in number of suicide was found among 45-54 year old people who were exposed to aircraft noise.

2- Psychophysiological Effects of Noise

Noise potentially produces stress and consequently affects performance of motor and mental tasks (Stream, 1980). Exposure to noise evokes a psychological stress reaction (Moller, 1978). which can cause physiological stress reactions that again produce physical and mental health problems (Kryter, 1980). There is strong suggestive evidence that aircraft noise is a casual factor in cases of cardiovascular disease (Knipschild, 1977 V). Emotional and environmental stress increases arterial blood pressure (Schmieder, et al., 1987). As all these stressors influence the cardiovascular system primarily via central nervous actions, the central nervous system appears to play a crucial role in the pathophysiology and etiology of arterial hypertension. Abel (1990) also concluded that loud noise of 100 *dB(A)* is purported to cause vasoconstriction with a consequent increase in blood pressure.

Increasing anxiety and emotional stress have been reported in noisy industrial plants (Cohen and Weinstein, 1981).

Studies on animals also has shown that prolonged exposure to moderate noise levels not only influence cardiac function (change in overall heart rate, proportion of missed beats and diurnal rhythm), but also these influences dissipate slowly after the exposure has ended (Peterson, et al., 1978). The workshop conclusion in Department of Environmental Hygiene, University of Gothenberg (Sweden) by Rylander (1978) also showed that exposure to noise, particularly to unexpected one or high level noise over a prolonged period, causes a reaction in the cardiovascular system (increases in heart rate, blood pressure and vascular constriction both in animals and human). The studies on animals by Jonsson (1978) showed a relationship between stress and cancer and also susceptibility to viral infection. Stressful conditions increased tumour incidence in response to polyoma virus (Eysenck, 1989).

Noise can produce a startling reflex which is usually caused by unexpected or unknown and loud sounds. This response represents a part of the stress reaction pattern (W.H.O., 1980). It involves the flexor muscles of the limbs and those around the eyes, causing in blinking, acceleration of heart beat, chemical change in blood and urine and changes in blood pressure. Also the startling response produces slow or deep breathing, reduces salivation, affects change in electrical resistance of skin

with change in activity of sweat glands, increases excretion of sweat from skin and secretion of corticoidal stress hormones and a dilation of pupils (Ahrlin and Ohrstrom, 1978; Kryter, 1980; W.H.O., 1980 and Wilkins, 1989). Change in white blood cell pattern and increases in total cell count (but a decrease in eosinophils and basophils) has been reported (Osada et al., 1973 quoted by Ahrlin and Ohrstrom, 1978). The startle reflex is difficult to suppress and habituation is low. However, there is no direct evidence that changes due to startle are associated with any harmful effect (Wilkins, 1989).

There is association between psychogenic headaches and different noises as ecological factors (general, family, pop music, sudden loud noise, angry shouting and automobile noise) (Sahay, 1990). Headaches may be associated with exposure to industrial noise (McKenna, 1988; Ohrstorm and Bjorkman, 1978) and other unpleasant psychophysiological effects including headaches, dizziness and nausea are associated with high levels of infra sound and ultra sound (Malerbi, 1989). A study on housewives around Osaka Airport (Japan) also show a higher percentage of nervousness and headaches. Also 38% of adult English households around Heathrow Airport (London) had a headache in the two weeks period of study (Mclean and Tarnopolsky, 1977).

Greater numbers of gastro intestinal complaints,

gastro intestinal ulcers, chronic gastritis, general digestive problems, cardiovascular problems, endocrine problems, increases in blood pressure, heart diseases and other stress-related syndromes have been reported in noisy industries compared to quieter ones (Ahrlin and Ohrstrom, 1978; Krichagin, 1978; W.H.O., 1980; Cohen and Weinstein, 1981).

The immune system also is extremely sensitive to environmental changes and noise as a stress factor produces effects on this system (Holt, 1978). The endocrine glands are usually the ultimate effectors of gross changes in immunological function and of these, the adrenal cortex exerts the most profound effect. Noise influences the immune system and involves increased production of adrenal cortical steroids which are cytolytic towards a subpopulation of lymphocytes in the thymus glands (Holt,1978). Medical records of 969 workers exposed to noise levels of 85-115 *dB(A)* compared with those working in levels of 70 *dB(A)* or less , show a higher prevalance of peptic ulcers and hypertension (W.H.O., 1980). Workers exposed to high intensity noise show a higher incidence of fatigue and irritability in the exposed group compared with the control (W.H.O., 1980). Intense infrasound (sound level about 100 dB at frequency 10 Hz) can give headache and tiredness (Bruel and Kjaer Ltd, 1980). Studies on animals exposed to high intensity noise also showed high rates of hormone, urine and noradrenaline discharge (Moller, 1978

and W.H.O., 1980).

Fatigue in a physiological context, includes measurable changes in the cardiovascular and respiratory systems. Increased pulse rates, breathing rate, oxygen consumption, and serum cholesterol levels whilst blood glucose level decreases (Mclean and Tarnopolsky, 1977; Stream, 1980; Cohen and Weinstein, 1981; Mckenna, 1988). Krichagin(1978) (referring to the studies of Bell, 1966) explains that exposure to noise caused impairment of capillary blood circulation and more cardiac complaints and high occurrence of neurosis among workers. Workers in high level noise showed more medical problems than workers in quieter parts (Ahrlin and Ohrstrom, 1978).

A study by Knipschild (1977 V) showed that in residential areas with aircraft noise the prevalance of cardiovascular diseases appears to be higher than in quieter areas.

The association between aircraft noise and consumption of sleeping pills, antacids, sedatives and drugs for the treatment of essential hypertension (Clark, 1984). Hypertension increases with noise exposure (McLean and Tarnopolsky, 1977) and it will be a risk for cardiovascular disease via increased blood pressure (Kristensen, 1989). Noise has rightly called a "silent killer" (Knipschild, 1980). A higher systolic and diastolic blood pressure among

the children from noisy schools compared to control groups (Cohen, et al., 1980). Alternatively 91 men working in engine rooms at sea, exposed to continuous loud noise during an average time of 27 occupational years showed no rise of blood pressure that could be related to this exposure (Delin, 1988). The experimental studies showed small but consistent effect of noise on cardiorespiratory function and diastolic blood pressure (Ettema and Zielhuis, 1977). Studies on 77 women of high and low sensitivity living in areas of high and low exposure to aircraft noise compared physiological indices showed highly noise sensitive women had a consistently slower heart rate and in the high aircraft noise area there was significantly more skin conductance response than in the low aircraft area (Stansfeld, et al., 1985).

A greater degree of both mental and physiological distress and ill-health have been observed among people living under aircraft path ways (Kryter, 1980). At Amsterdam and Schiphol airports (Netherlands) there were a high proportion of psychological and psychosomatic (like low back pain and spastic colon) complaints in the high noise areas (Knipschild, 1977 IV) and more purchase of hypnotic and sedatives. The purchase of antacids for a period of six years gradually increased to twice the initial but sedatives and hypnotics had increased in the beginning of aircraft noise and decreased when the number of night flights was diminished (Knipschild and Oudshoorn,

1977). In areas with more aircraft noise around Schiphol Airport the use of sedatives and hypnotics and for female patients also the use of antihypertension agents was higher (Knipschild, 1977 VI). An association between aircraft noise with NNI >33 and contact with G.P. (general practitioners) has been reported in residential areas of Schiphol airport by Knipschild (1977). It was 2-3 times as often in the NNI 45-55. A study by Watkins, et al., (1981) in areas of different aircraft noise exposure affected by Heathrow Airport (London) shows an inconclusive relationship between level of aircraft noise and various drugs treatments, visits to the general practitioner, out patients clinics or in the use of health and community services and hospitalisation . The use of non-prescribed drugs was significantly higher among "very annoyed" than among "less annoyed". The uptake of psychotropic drugs and the use of general practice and out-patient services tended to increase with increased annoyance both in high and low noise areas.

Workers in a jet engine plant exposed to various noise levels show loss of appetite and nausea in 31 percent (Bugliarello, et al., 1976). Study on 140,000 patients registered at the out patient departments of different hospitals showed 2-4 fold increase in hypertension, nervous disorders, gastric ulcers and auditory diseases in Aircraft noise exposed groups (W.H.O., 1980). However, Grandjean (1974) suggested that there was no correlation between

psychophysiological symptoms and exposure to aircraft noise. A study on aircraft noise around Munich Airport showed no sign of diseases (W.H.O.,1980). A higher incidence of nervous diseases in noisy areas around Netherlands Airports has been reported by Knipschild (1977, VIII). Also a study by Meecham and Shaw (1988) on health effects of aircraft noise on residents around the Los Angles Airport showed 18 % increase in cardiovascular death of people over 75 years age who were exposed to aircraft noise compared with unexposed ones .

The over all conclusions of a review by Smith (1991) show that noise induced physiological responses , if prolonged, have harmful effects on health. The strain due to undesirable physiological effects of noise cause a state of bodily ill-health or create a hazard for physical and mental health (Rylander, 1978; Kryter, 1980 and W.H.O., 1980).

3- Psychiatric Disorders

Reactions to noise may vary from realistic and normal expressions of annoyance to the development of psychotic episodes which are clearly abnormal and require treatment (Clark, 1984). Noise can lead directly or indirectly to psychiatric morbidity. Different investigators have attempted to correlate noise and psychiatric illness. In

all experiments considerable attention has been paid to this aspect, though, some results are contradictory. If noise causes annoyance and frustration it could cause or aggravate mental illness (Cohen, et al., 1981). Otherwise, environmental noise was not a cause of psychiatric disorders, however, there is consistent association between noise sensitivity and psychiatric disorders with noise sensitivity being a vulnerability factor for the effects of noise on mental health (Stansfeld, 1988).

A number of studies have examined relationships between industrial noise and psychiatric diseases. Their results describe a positive correlation between noise-exposed workers and psychiatric morbidities (Mclean and Tarnopolsky, 1977; Dejoy, 1984 and Smith and Stansfeld, 1986). However; Mclean and Tarnopolsky concluded that there is no direct effect of noise on the prevalence of psychiatric disorders.

The relationship between aircraft noise and mental hospital admission has been investigated by several authors. Studies around large international airports (including Heathrow) support the view that exposure to aircraft noise is associated with illness (Jenkin, et al., 1981). Abey-Wickrama, et al., (1969) found a higher percentage of mental hospital admissions among the people living in the noisy areas around Heathrow Airport (London). They found an increased rate of admission to

Springfield Hospital compared to other hospitals and concluded that may be due to exposure to aircraft noise. A significant relationship existed between exposure to aircraft noise and mental hospital admission. However Chowns (1970) with data analysis of this study concluded no significant association between aircraft noise and mental hospital admission rates, but another study carried out in the vicinity of Heathrow Airport (London) by Herridge and Chir (1972) also showed a statistically significant relationship between mental hospital admissions in high noise area (over 55 NNI), at the same hospital. Gattoni and Tarnopolsky (1973) between July 1970 to June 1972 used a different method and showed an increase in mental hospital admissions from higher noise areas. Jenkins, et al., (1979,1981) compared hospital studies around Heathrow airport and confirmed differences between the population of high and low noise areas. The third published study of admissions to Springfield Hospital around Heathrow Airport(Jenkins, et al., 1979) show conflicting results with earlier findings . An increased admission rate in lower noise exposure suggests a different method for earlier studies causing conflicts in results. Re-examination of Kryter's data (1990) shows that aircraft noise exposure level above an Ldn of 58 is significantly predictive of an increase in psychiatric hospital admissions. An increase of about 40% in psychiatric hospital admission rates is associated with an increase in exposure levels of aircraft noise from about Ldn 58 to Ldn

77. He also reported some individual differences such as a greater rate of psychiatric hospital admissions for over 45-year old, females, and single people. Mental hospital admissions from residential areas around Los Angeles International Airport (Meecham and Smith, 1977) showed a positive relationship with exposure to aircraft noise. There was 29% increase in mental hospital admission from the maximum noise area (90 dB) compared to the control area.

A study near Swiss airports (Grandjean, 1974), using a 30-item self-rated questionnaire suggested that exposure to aircraft noise was not a significant cause of psychiatric illnesses. However a relationship existed between aircraft noise and the rate of contact with local general practitioners (Bugliarello, et al., 1976; Smith and Stansfeld, 1986 and Tarnopolsky, 1978). Hand, et al., (1980) found no significant interaction between aircraft noise and mental hospital admissions, and Tarnopolsky, et al., (1980) also suggested no relationship between aircraft noise and psychiatric morbidities.

The economic situation is another factor in high noise environments near airports. These are often associated with poorer living conditions in general and such conditions are linked with psychiatric illness in the community where noise exposure exacerbates minor psychiatric symptoms (Clark, 1984). Jenkins (1981) also

suggested no evidence for an overriding effect of aircraft noise on psychiatric admission, because of many other causal factors beyond those which were examined. Kryter (1980) suggested that statistics and measures of ill-health can be significantly influenced by non-noise factors such as socio-economic conditions, population selection and air pollution.

It seems that noise sensitivity is associated with psychiatric illness (Smith and Stansfeld, 1986) but, associated with neurotic depression rather than the more severe, psychotic depression (Stansfeld, 1988). According to Loeb (1986) studies by Argulles, et al., (1970) show that noise increased alcoholic psychosis and schizophrenia.

Data collected around Los Angeles Airport (Meecham and Shaw, 1988) from 1970 to 1980 decade showed a significant increase of death rate in noise impacted areas. There was an increase of over 60 deaths per year in noisy areas.

Cohen, et al., (1986) have pointed out a relationship between physical illness and persons exposed to intense environmental stress on a daily basis. Noise as a stressful factor in community and industry elevates coronary heart disease among exposed groups. They suggested because of stress causing neurochemical changes in the brain, stressors affect health by causing changes in behaviour that is inimical to health with high illness-

related absenteeism in noisy industries (Loeb, 1986).

However, if the eye is exposed to ultrasound the fluid in the lens becomes more viscous, but very rarely comes in contact with man as it is strongly absorbed during propagation through the air (Bruel and Kjaer Ltd, 1980).

In the light of the studies it is clear that aircraft noise affects humans physically, mentally and physiologically. This indicates that aircraft noise is an important physical factor in human life which threatens health and needs more attention.

Results and Discussion

The studies on the effects of noise on mental health has focused primarily on admission rates to mental hospitals among residents exposed to aircraft noise. A positive relationship exist between aircraft noise and mental hospital admissions was found by some investigators (Abey-Wickrama, et al., 1969; Herridge and Chir, 1972; Gattoni and Tarnopolsky, 1973; Kryter, 1990) but the evidence is conflicting in that aircraft noise is one of several causative factors which increase psychiatric illness.

Self-reported psychological and psychophysiological factors may establish a relationship with aircraft noise

exposure. It is the most important environmental factor causing people to dislike their area (Fig.7.9) and encouraging them to move. Those dissatisfied with aircraft noise (Fig.7.8) are concerned about threats to their health (Fig.7.15). Aircraft noise also causes fear amongst exposed people (Fig.7.11) and the feeling of insecurity is an important factor affecting the psychological aspect of human life.

The psychophysiological effects of aircraft noise on teachers and the self-reported responses show that 71% of teachers feel that they become more tired after teaching due to aircraft noise (Fig.8.1). 56% of respondents rated that aircraft noise gave them headaches "occasionally" to "very often" (Fig.8.2). Teachers who were teaching in high noise level area (NNI=56) reported more tiredness and had more headaches (Figures. 8.1.1 and 8.2.1). 83% of women teachers believe that aircraft noise causes more tiredness and 71.5% rated that it gave them headaches. For men it was 56% and 37% respectively. The differences between teachers self-reported psychophysiological responses at different schools, showed that over 73% of those felt tired and 40% rated aircraft noise as a cause of their headaches teaching at primary schools. The percentages for secondary schools are 80% and 74%, while for high schools are 60% and 44%. Teachers whose teaching is significantly affected by

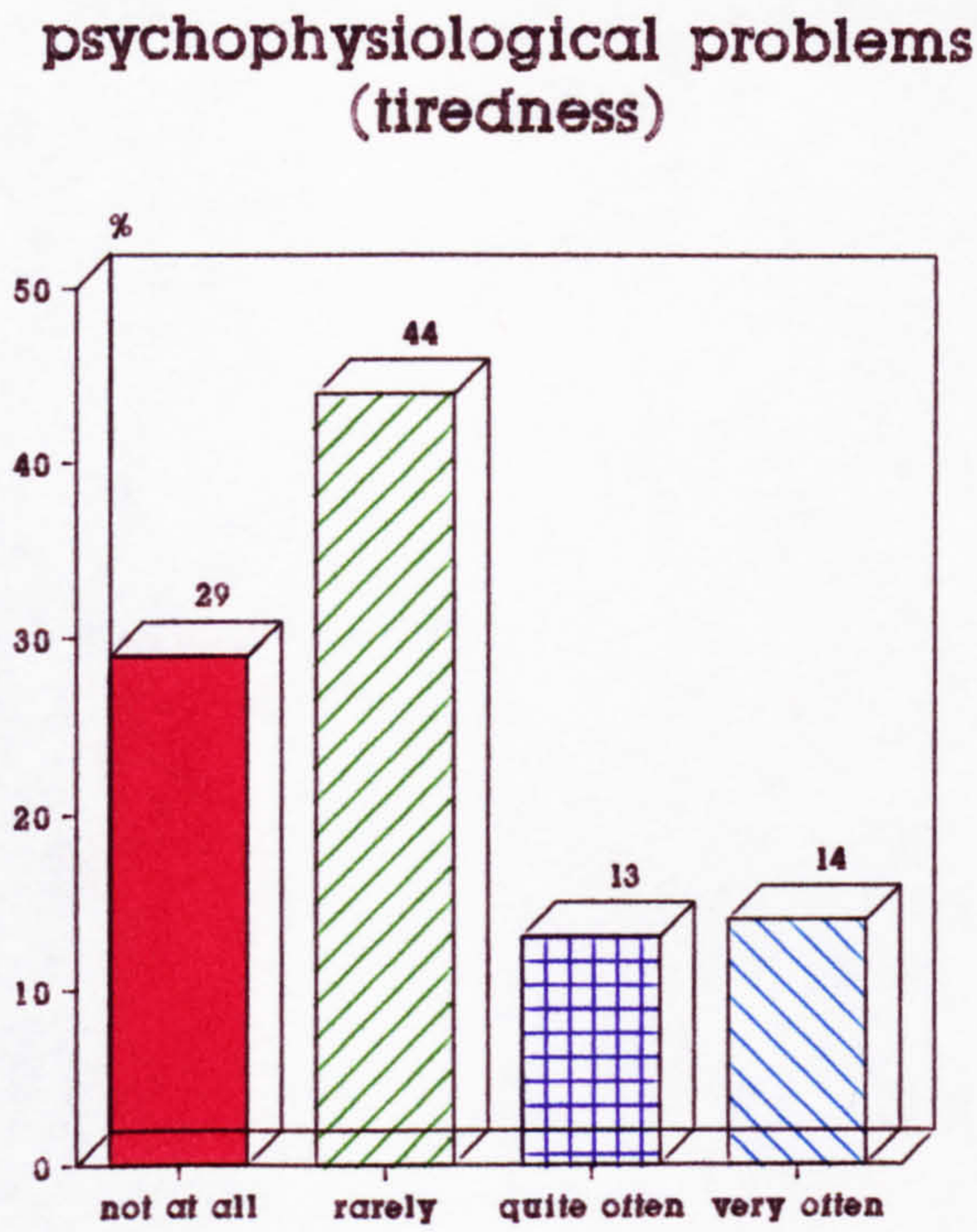

Fig.8.1 : tiredness amongst teachers

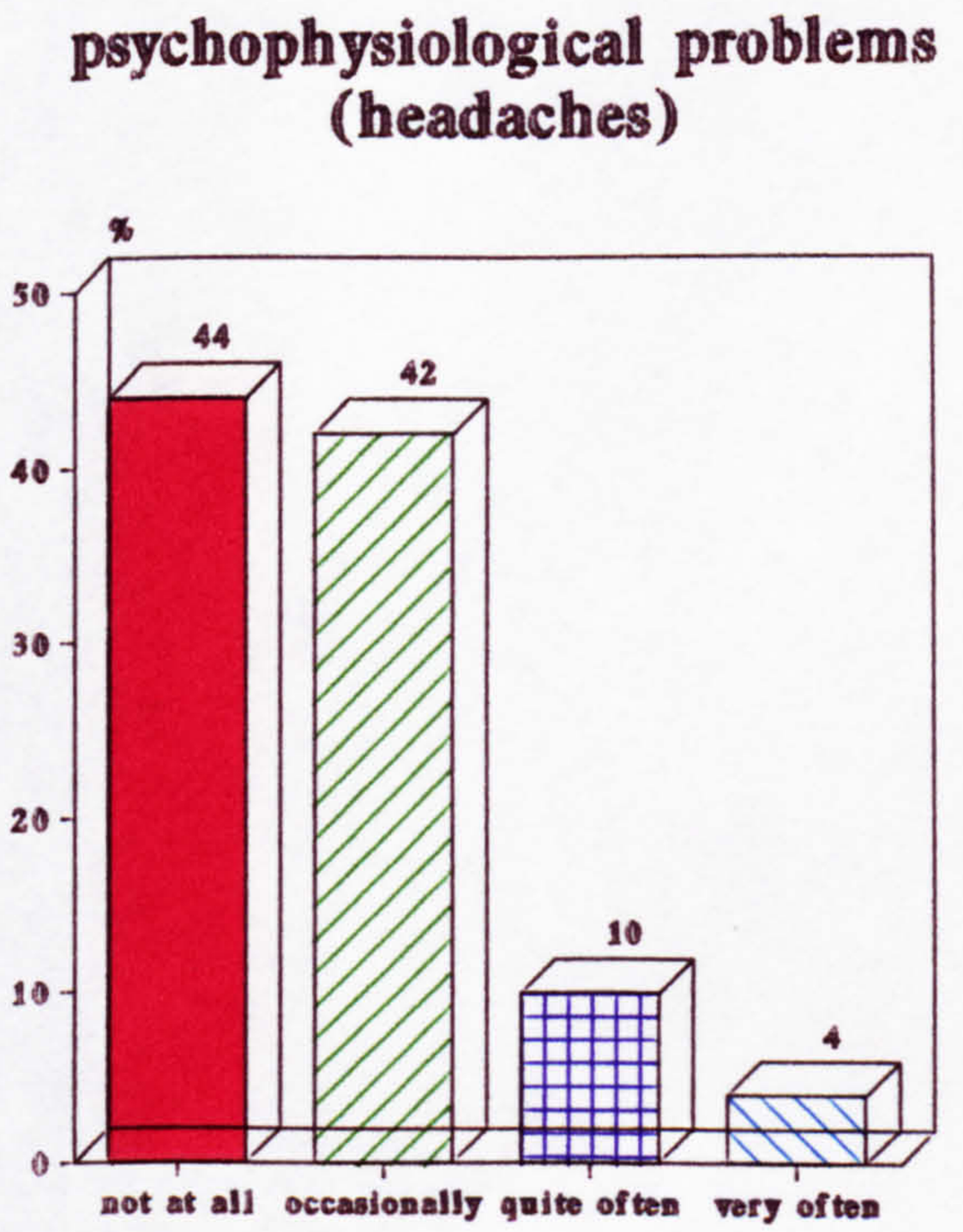

Fig.8.2 : headaches amongst the teachers

degree of tiredness amongst teachers at different noise levels

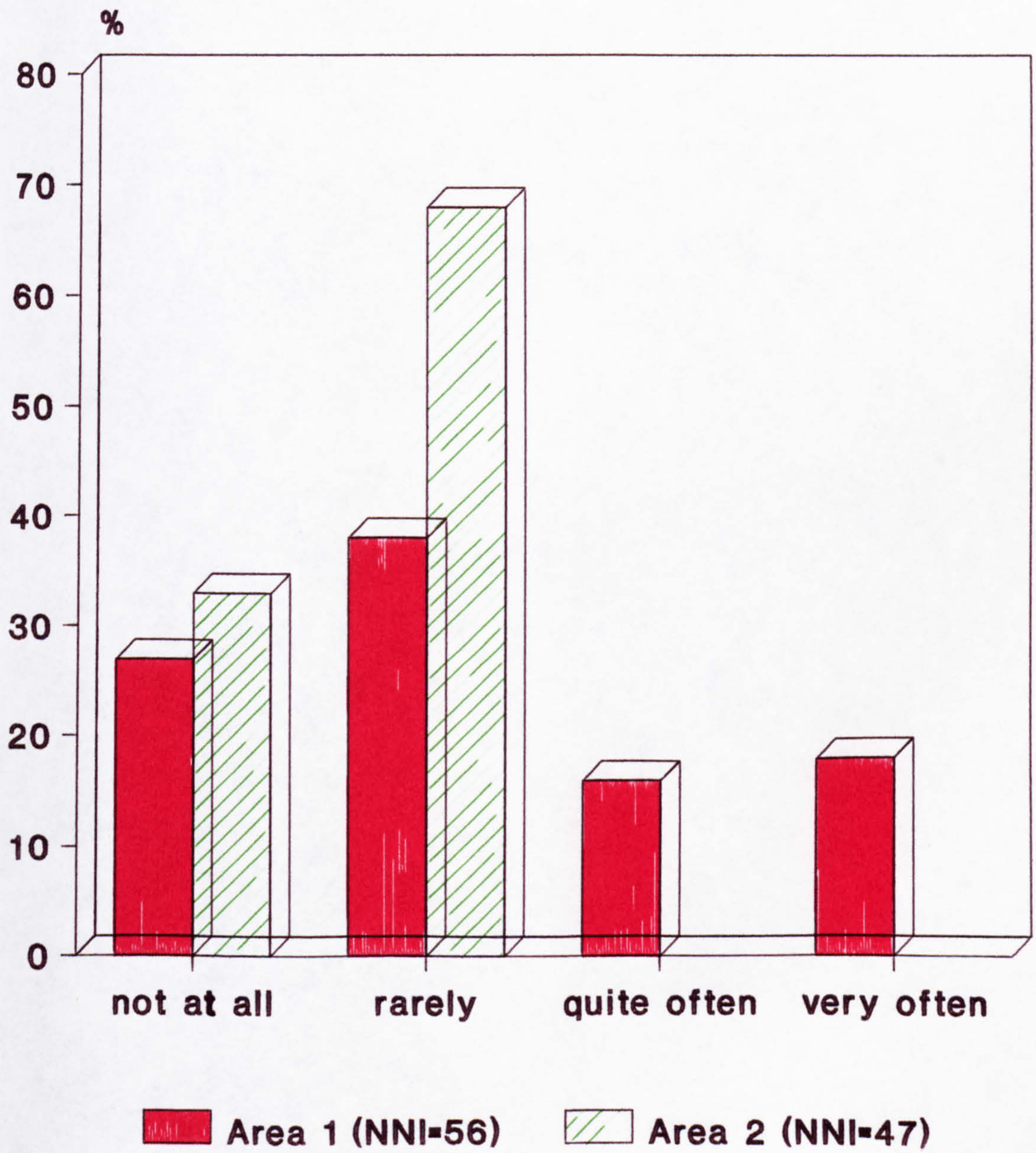

Fig.8.1.1.

Comparison of headaches amongst the teachers at different noise levels

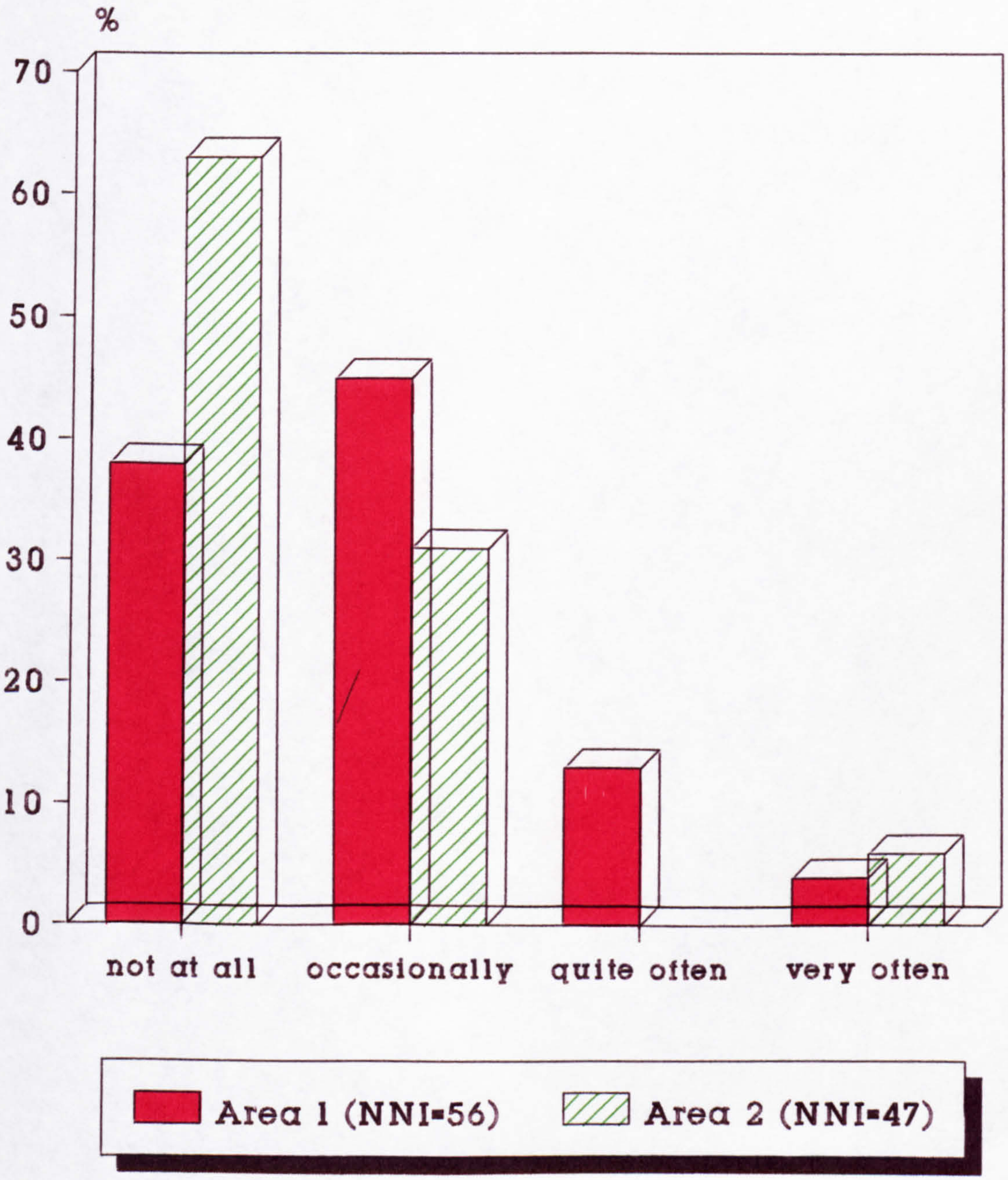

Fig.8.2.1.

aircraft noise also reported tiredness and headaches. This supports previous studies by Mclean and Tarnopolsky (1977).

Self-reported psychophysiological effects of aircraft noise on residents around Mehrabad Airport indicates a relationship between psychophysiological problems and aircraft noise (Figures 8.3-8.7). A considerable number of people are suffering psychologically from aircraft noise. (Fig. 8.8). These factors themselves could affect the human life style. A person with headaches, fear, tiredness and nervous does not enjoy life to the full. Married people reported more psychological and psychophysiological problems than single people (Figures, 8.5 and 8.9). The results indicate the relationship between the type of employment, education level, gender and psychological problems due to aircraft noise (Figures 8.10-8.11).

Above NNI 45 , considerable percent of people complain psychophysiological and psychological problems due to aircraft noise. There were only minor and inconsistent differences in level ranges (Table 10). This does not mean that lower ranges are necessarily safe, as the medical effects of aircraft noise are demonstrated at level above 33 NNI (Knipschild, 1977).

Psychological, physiological and behavioral effects are linked to each other (Kagan, 1980). The W.H.O.

pcychophysiological problems
(residents)

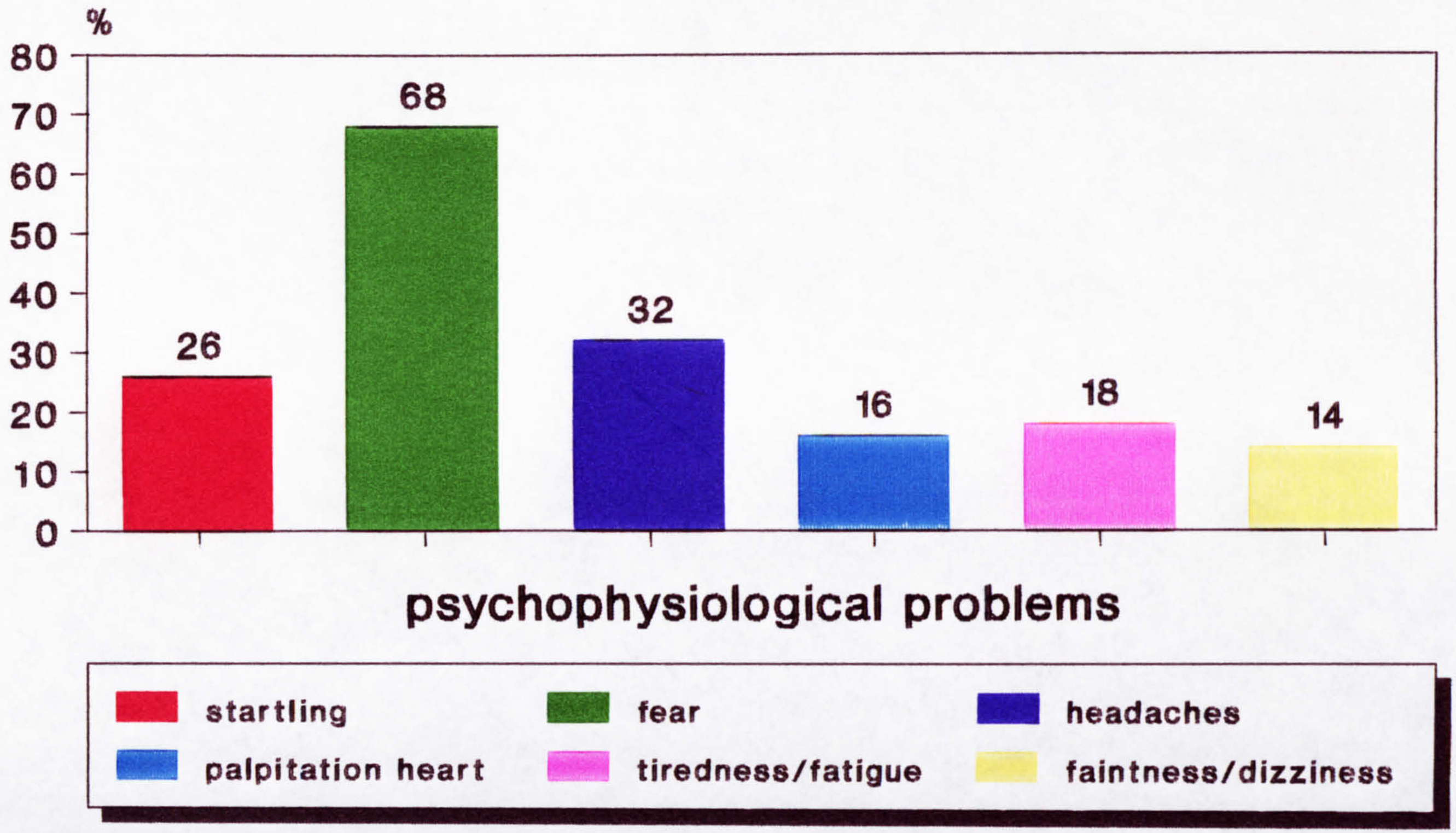

Fig.8.3.

Psychophysiological problems due to aircraft noise(male/female)

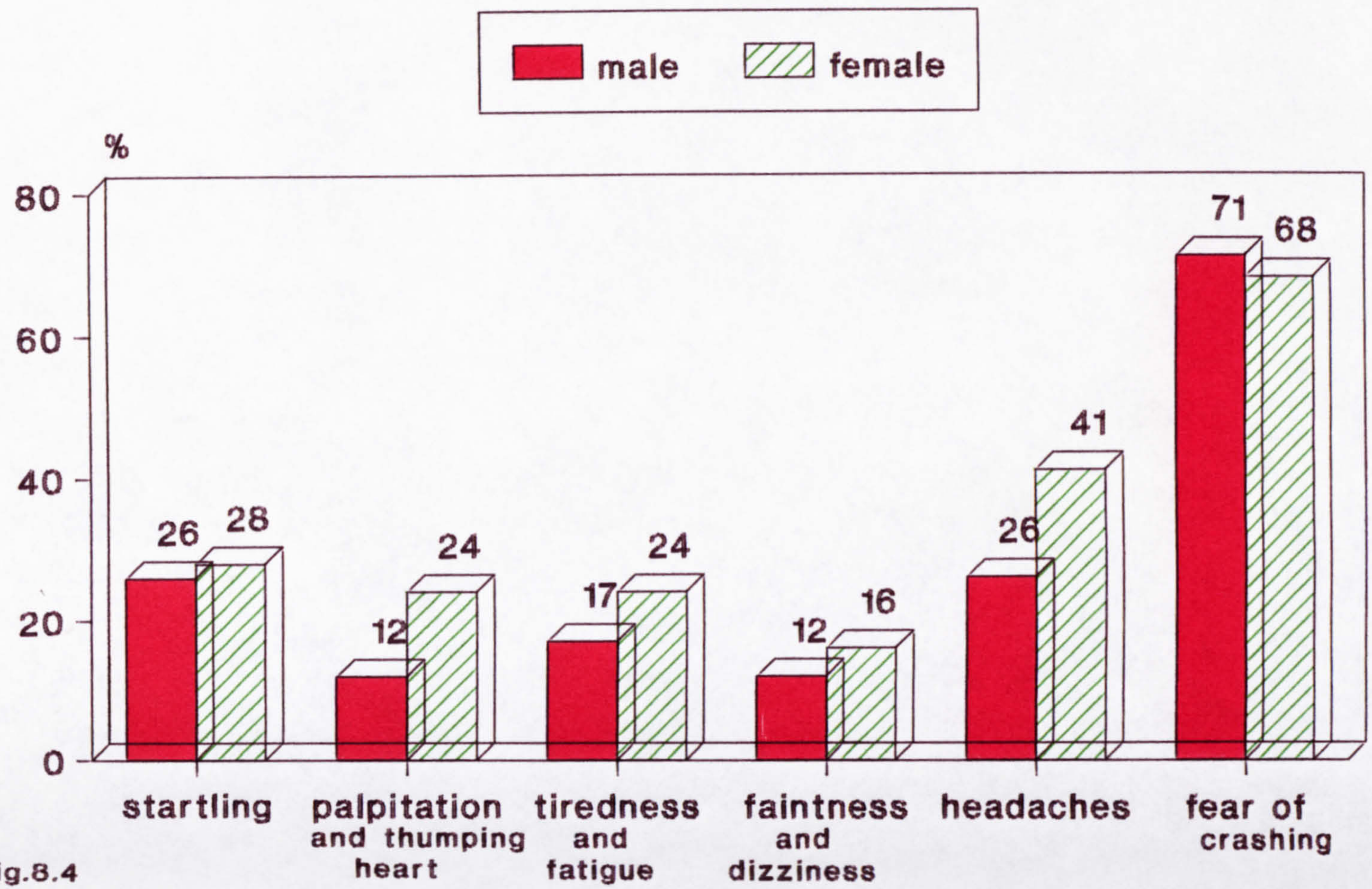

Fig.8.4

psychophysiological problems due to aircraft noise (single/married)

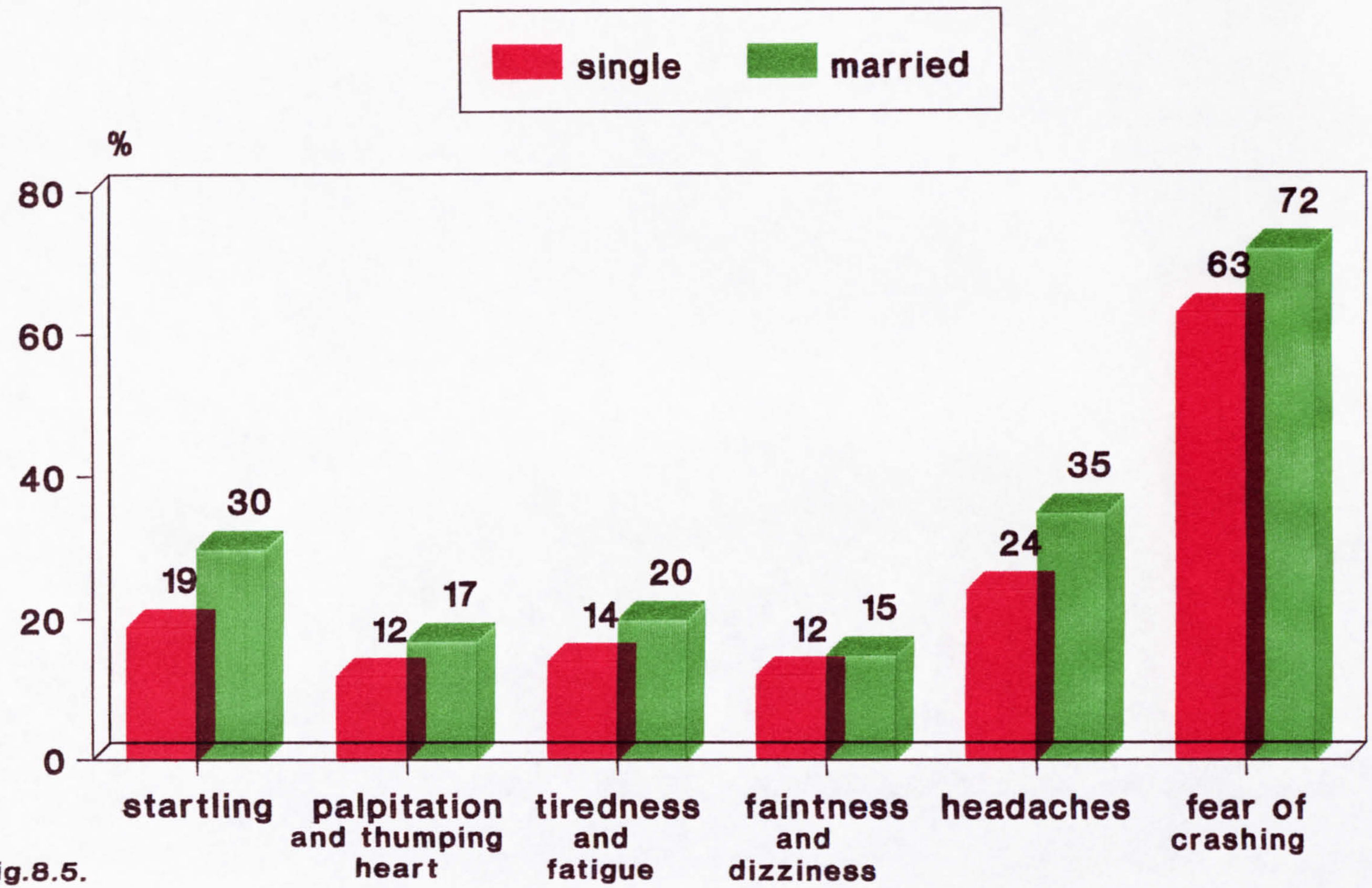

Fig.8.5.

psychophysiological problems due to aircraft noise (education level)

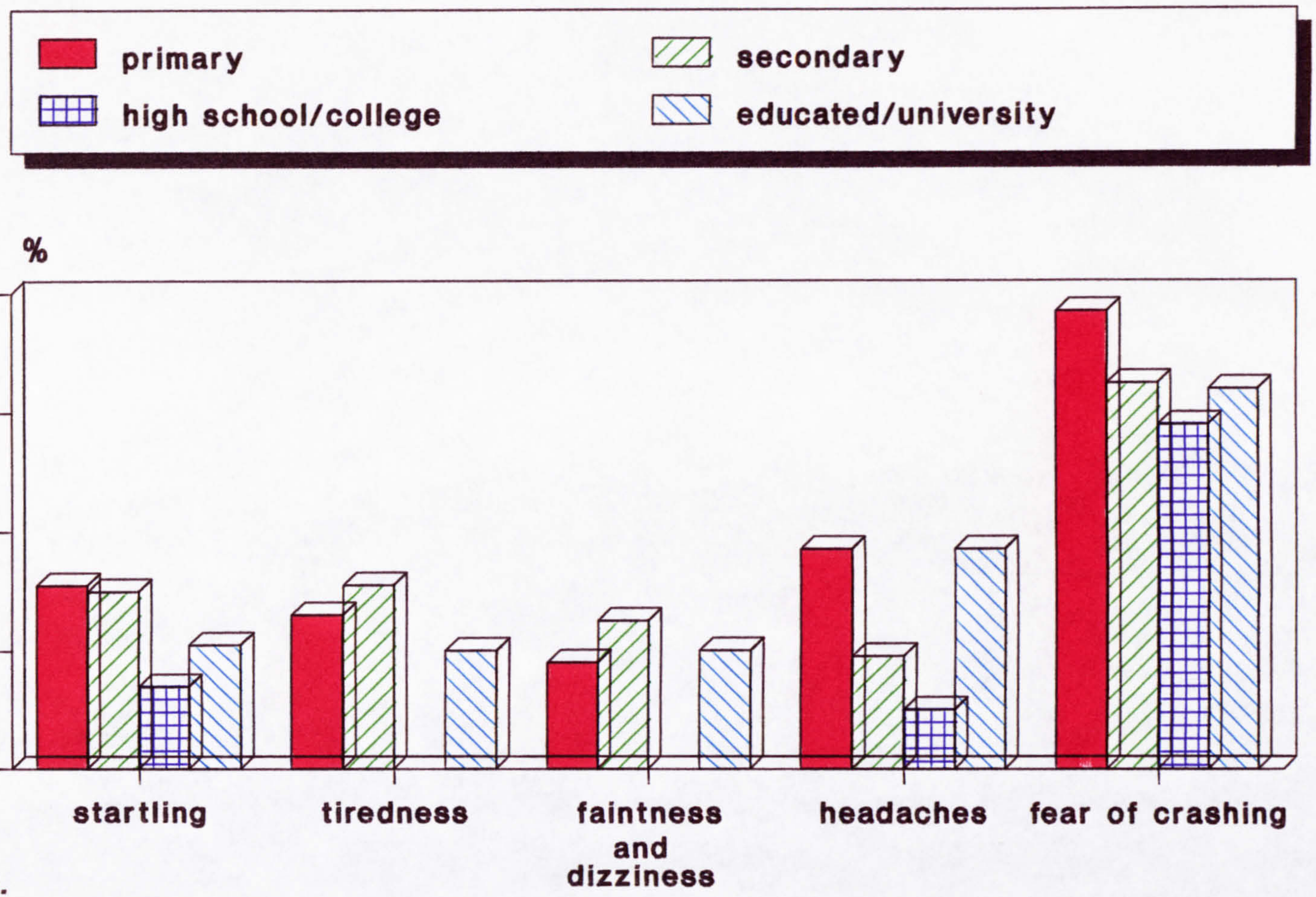

Fig.8.6.

psychophysiological problems due to aircraft noise (occupations)

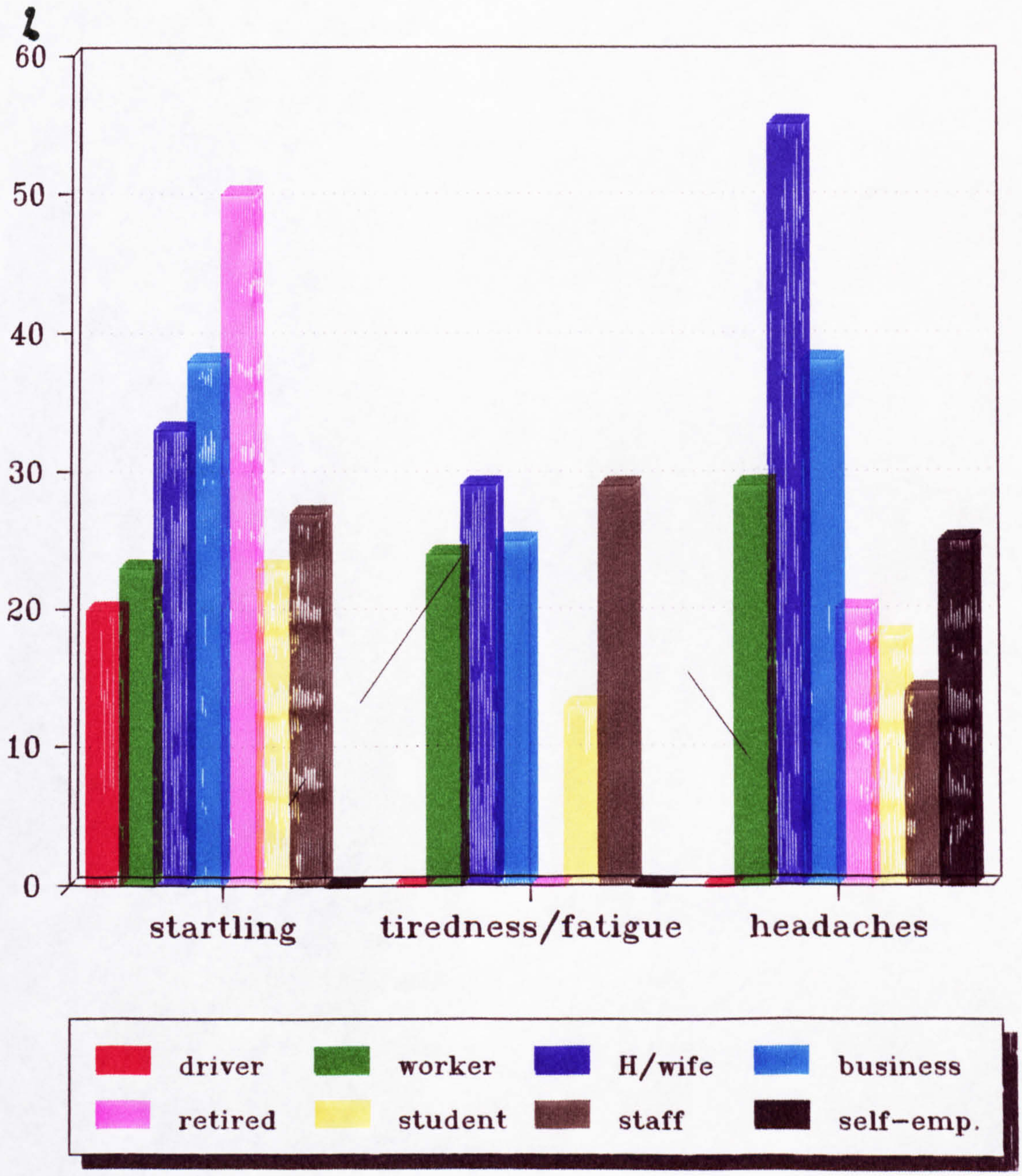

Fig.8.7.

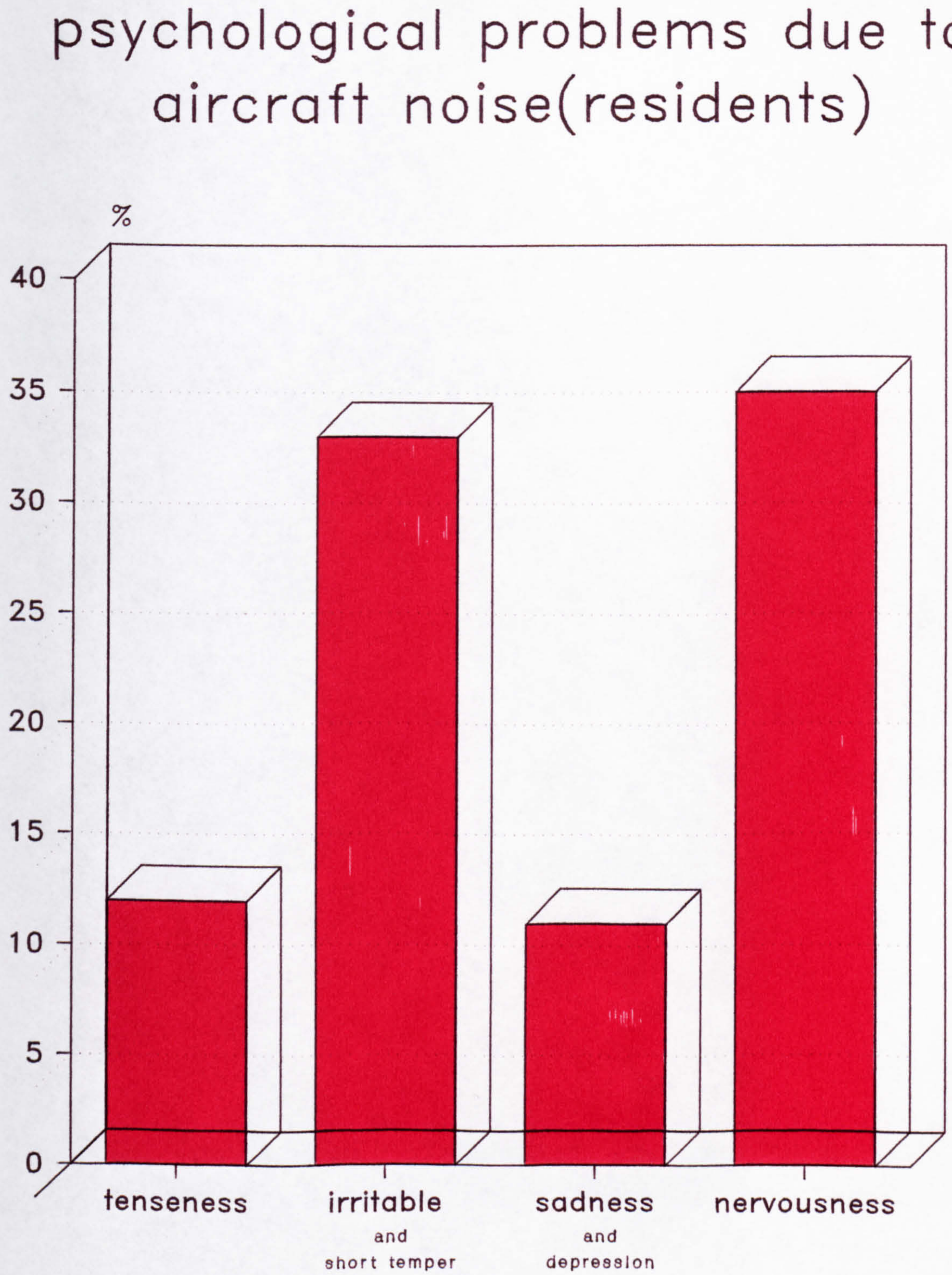
psychological problems due to aircraft noise(residents)
%
40
35
30
25
20
15
10
5
0
tenseness
irritable and short temper
sadness and depression
nervousness

Fig.8.8.

psychological problems due to aircraft noise(single/married)

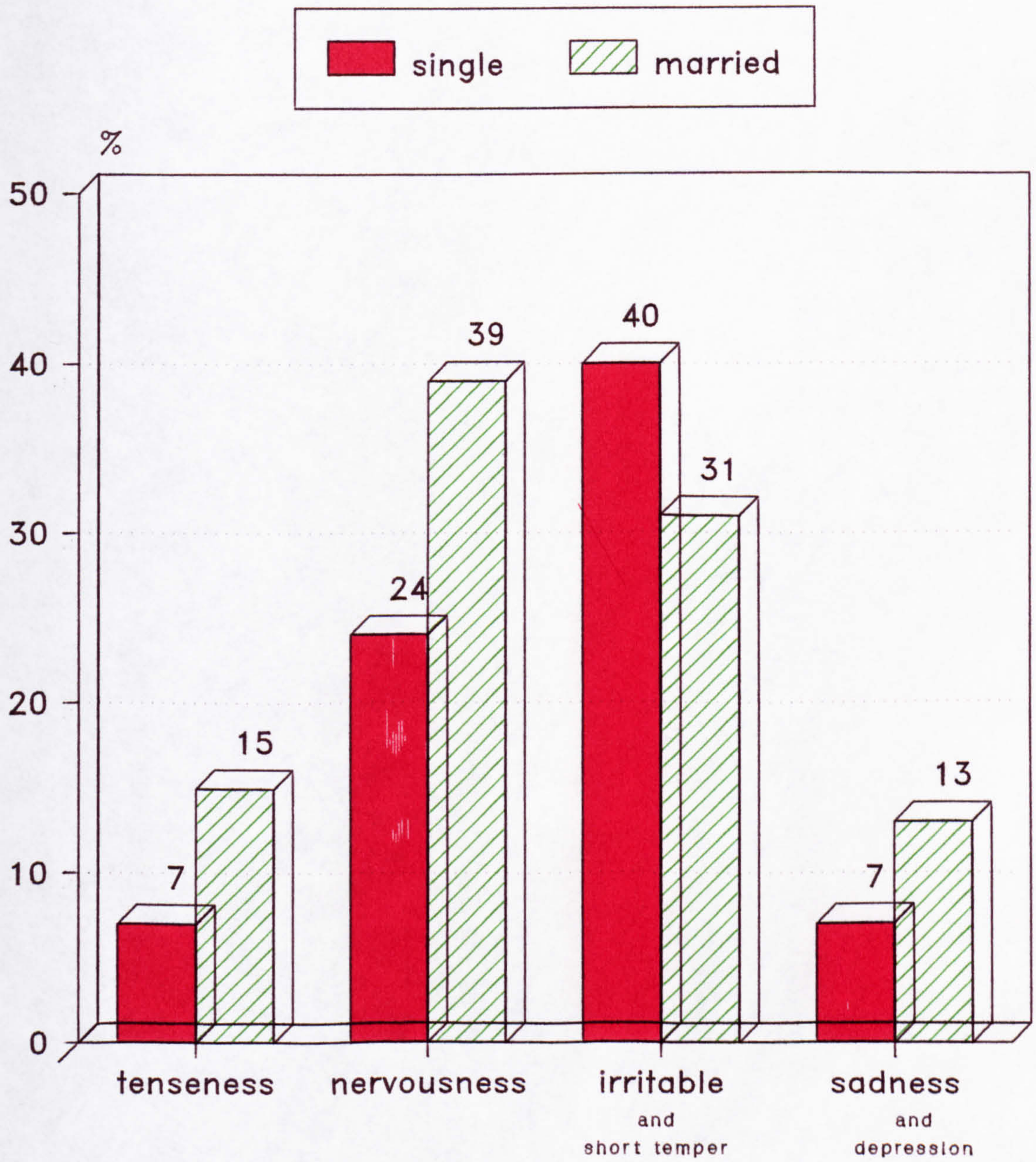

Fig.8.9.

psychological problems due to aircraft noise (occupations)

Fig.8-10

psychological problems due to aircraft noise (education level)

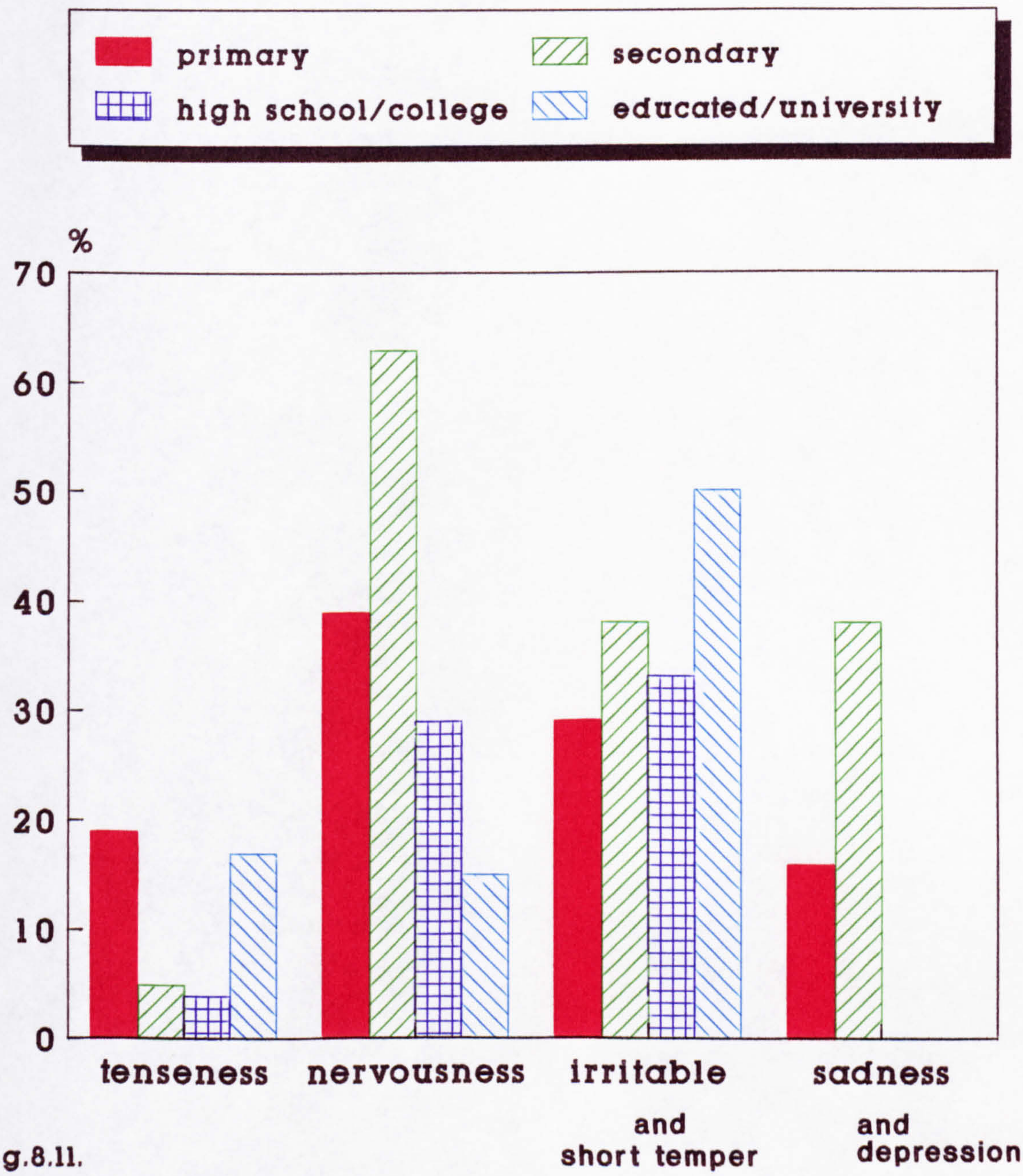

Fig.8.11.

Table 10 : Comparative percentages of Psychological and psychophysiological problems in different areas

Disturbances	NNI=46 (area 1)	NNI=47 (area 2)	NNI=53 (area 3)
Tenseness	13	10	16
Headaches	35	33	28
Nervousness	28	56	17
Palpitation and thumping heart	20	16	15
Irritable and short temper	37	32	33
Tiredness and fatigue	17	20	17
Sadness and depression	15	10	9
Faintness and dizziness	22	8	13
Take pill for nervous	15	10	11

definition (constitution, 1948), " health is a state of complete physical, mental and social well-being not merely the absence of disease and infirmity" is still extensively quoted though W.H.O. has developed its view considerably since that time (W.H.O., 1984). According to this definition, it may be concluded that exposure to noise in the community is harmful to the general well-being of people.

The health of resident respondents was subjectively evaluated through enquiring about 5 levels ranging from "very poor" to "very good" health. The distribution of responses was "very poor" 5% , "poor" 16%, "average" 40%, "good" 24% , and "very good" 16% from a total of 193 respondents.

An explanation for the additive effects of the present study centred on the specific effect of aircraft noise on the number of family members. The comparative analysis (Khajehnoori and Sekhavat, 1978) between family size in Tehran (Iran Statistical Centre, 1991) and the sample around the airport shows a significant relationship between the aircraft noise and family size (P=0.01). The mean number of family members studied is significantly more than the mean of family size in Tehran. This means aircraft noise is a negative factor for family planning. Because of noise disturbance to sleep it is likely that sexual activities are greater than in quieter areas, family

size around the airport is greater than the mean of Tehran. However some industrial studies have shown high level of noise (110 dB or above) cause sexual impotence (Cohen and Weinstein, 1981). Large families in Tehran significantly reported more psychophysiological and psychological problems (headaches, irritation and short temper, tiredness and fatigue, faintness and dizziness and high blood pressure). If we agree that aircraft noise is a factor increasing family size we will also agree that aircraft noise is a risk factor for human health.

CHAPTER IX RESULTS AND CONCLUSIONS

CHAPTER IX RESULTS AND CONCLUSIONS

Each chapter has included a results section with discussion based on each parameter being evaluated. The overall conclusions derive from these data and emphasize the wider implication of the effects of airport noise.

EDUCATION

More than 52% of teachers in institutes near Mehrabad airport believe that aircraft noise affects their professional efficiency and performance (Fig.5.4) and about 60% of them reported speech and teaching interference (Fig.5.4). Aircraft noise causes about 80% of teachers to abandon lessons and activities "occasionally" to "very often" (Fig.5.8) and 77% of teachers were forced to make changes whilst teaching when aircraft were flying over (Fig.5.4). This itself is a significant cause of dissatisfaction with aircraft noise (P=0.004) due to headaches (P= 0.009), tiredness (P=<0.001) and annoyance (P= 0.02).

A significant association was found between lesson abandonment due to aircraft noise and reported headaches (P=0.001) and tiredness (P=<0.001). Tiredness and headaches cause significant annoyance and dissatisfaction of the

teachers within the area and consequently force them to wish to change schools (P=0.001).

Aircraft noise causes pupils loss of concentration and therefore, intakes them less inclined to work and become disruptive (Fig.5.4). This obviously affects the performance and efficiency of teachers. Teachers who have worked in noisy areas for a long time suffer from aircraft noise as much as new staff. Aircraft noise influences the performance and efficiency of experienced teachers as much as inexperienced (fig.6.6) and the degree of lessons' abandonment significantly increased with the length of service at their teaching place (P=0.02). There were only minor and inconsistent differences between self-reported headaches and tiredness due to aircraft noise amongst the new teachers and those who have worked a long time in the area (Fig.6.7)

Teachers tiredness and headaches due to aircraft noise (Fig 8.1 and 8.2) were reported more by women teachers (P=0.04) who have more headaches (P= 0.01) than men. Consequently they feel more annoyed (P= 0.02). Most teachers (91%) in institutes near Mehrabad Airport are annoyed by aircraft noise (Fig 7.2). More complaints of headaches and tiredness were reported by teachers in noisy area, but it was only significant for tiredness. A significant relationship was found between the degree of lessons abandonment and noise level (P=0.04).

Teachers in schools near Mehrabad Airport, therefore, suffer severely from aircraft noise and the inconvenience of interruption and the need to change teaching procedures. There is no evidence of adaptation to aircraft noise amongst teachers.

The quality of education in areas near the airport. is a factor affecting the development of individual potential and capability. It is a factor frustrating the creation and generation of abilities which is an essential element in the human development process. As aircraft noise has negative effects on the development of individuals' ability it must also be influencing the capacity of national development. There needs to be more effort to reduce and control aircraft noise and prevent schools and educational institution being built near airports.

SLEEP, RELAXATION AND PEACE OF MIND

Statistical results demonstrate that aircraft noise affects sleep, rest and relaxation. Considerable numbers of people are disturbed by aircraft noise (Fig.4.1) and it is the strongest environmental factor which awakens residents around Mehrabad Airport (Fig. 4.3). There is a significant relationship between sleep disturbance due to aircraft noise, and annoyance ($P=<0.001$). Therefore, sleep

disturbance could be a main reason for annoyance. The better educated and retired people reported more sleep disturbance due to aircraft noise than others (Figures 4.3,4.6).

Aircraft noise is an important factor which interferes with the communication of residents around airports (Fig.5.7). Communication interference is a significant reason for dissatisfaction with aircraft noise in residential areas (P=0.001). The relationship between communication interference and self-reported psychological problems can be after effects of communication interference. Those who sense aircraft noise interfering with the audibility of radio and T.V. significantly report tenseness (P=0.01), tiredness and fatigue (P=0.01), sadness and depression (P=0.004), increased pill consumption for their nervousness (P=<0.001) and complaints of chest pains (P=<0.001). T.V. picture flicker is also a significant factor. Single and self-employed people reported more interference with their conversation and problems with the audibility of radio and T.V. due to aircraft noise (Fig.5.7.1, 5.7.3). The better educated had more complaints about communication interference due to aircraft noise (Fig. 5.7.2).

A significant relationship was found between "tinnitus" and irritability and short temper (P=0.02), faintness and dizziness (P=<0.001), headaches(P=0.03) and loss of

appetite(P=<0.001).

ANNOYANCE, AND OTHER HEALTH EFFECTS

91% of local residents reported that they were annoyed by aircraft noise (Fig 7.6), and residents consequently dislike living around Mehrabad Airport (Fig. 7.9). It is clearly the most severe noise experienced by respondents (Fig.7.10) and the most negative factor in the neighbourhood evaluation (figures 7.9, 7.9.1, and 7.10). There is a significant negative relationship between the degree of satisfaction about living where they are and being bothered by aircraft noise(P=0.001). Startling (P=<0.001), house vibration (P=0.006), and communication interference (P=0.02) due to aircraft noise, fear of aircraft crashing (P=<0.001) and sleep disturbance (P=<0.001) are significant underlying reasons for aircraft noise annoyance. Those who experience aircraft noise inside their homes are more annoyed (P=<0.001).

Parents who believe their children are affected by aircraft noise, experienced significantly more sleep disturbance (P=0.003) and annoyance (P=0.01) due to aircraft noise and dislike their area and wanted to move (P=0.002). Noise from aircraft was the must frightening experience of children (Fig. 7.12).

Communication interference (P=0.001) and sleep disturbance (P=<0.001) are significant reasons for dissatisfaction with aircraft noise . Those who believe aircraft noise is a harmful factor for their health are significantly more annoyed by aircraft noise (P=<0.001)

The fear of aircraft crashing 68% of residents (Fig 7.11) caused more sleep disturbance due to aircraft noise (P=<0.001). When houses vibrate there is a significant fear of aircraft crashing (P=<0.001). Residents afraid of aircraft crashes significantly report greater aircraft noise annoyance than people who are not (P=<0.001). There is an association between fear of aircraft crashing and psychophysiological symptoms [startling (P=0.002), headaches (P=0.02), tiredness and fatigue (P=<0.001)] and psychological experiences [tenseness, nervousness (P=0.004)].

The perception of aircraft noise as 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).

The sleep in more noisy areas was more disturbed than in quieter areas (Table 9). Inconsistent differences between psychophysiological and psychological effects in studied areas with different noise levels (Table 10). NNI greater than 45 is considered a serious health risk by

observation on residents.

Most people questioned (95%) believe that aircraft noise threatens their health "a little" to "very much". The proportion of people who rated "very much" is 57% (Fig.7.15). A considerable percentage of people reported psychological and psychophysiological problems due to aircraft noise (Figures 8.3 and 8.8). Housewives had more complaints of headaches and tiredness and startling due to aircraft noise (Fig. 8.7). Women reported more psychophysiological problems than men (Fig.8.4) and married people more than singles (Fig. 8.9), but the differences are not statistically significant. People in business reported more nervousness and retired people rated more tenseness than others due to aircraft noise (Fig. 8.10).

Large families complain more significantly of headache (0.03), irritation and short temper (0.01), tiredness and fatigue (0.004), faintness and dizziness (P=0.006) and high blood pressure (P=0.02). Aircraft noise is a significant (P=0.01) factor which increases family size. When the areas are separately tested it was significant for area which is exposed to both aircraft and traffic noise.

There is a significant relationship between chest pains (P=<0.001), sore throat (P=0.01), eye trouble (P=0.01) and startling due to aircraft noise. There is 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 and fatigue (P=<0.001). Those who rate house vibration due to aircraft noise significantly reported more chest pain (P=0.005), breathlessness (P=0.007), irritability and short temper (P=0.03), nervousness (P=0.005), tiredness and fatigue (P=0.007) and nightmares (P=0.01). More psychological and psychophysiological problems are reported by people who rated poor health. They reported faintness and dizziness (P= 0.001), headaches (P= 0.006), irritation and short temper (0.002) and loss of appetite (P=<0.001).

Aircraft noise affects the sleep, rest and relaxation of people and interferes with their communication. Considerable numbers are annoyed and dissatisfied with aircraft noise, and consequently are not satisfied with their setting and would like to move. They are worried about the health effects of aircraft noise and are in fear of crashes. This insecurity amongst residents must complicate the diverse psychological and psychophysiological problems which arise. This is chronic situation and raises questions about the welfare of those exposed to these noisy situations which have yet to be addressed.

The definition of health by the W.H.O. is " a

state of complete physical, mental and social well-being not merely the absence of disease and infirmity". Based on this definition it may be concluded that exposure to noise in community is harmful to the general well-being of people. The overall conclusion prompted by this study on aircraft noise, is that it is a significant environmental factor which has negative effects threatening human health and which requires more effective controls and more consideration in future city planning.

CHAPTER X RECOMMENDATIONS

CHAPTER X

RECOMMENDATIONS

Common noise control

Introduction

On an equal energy basis , an increase of 3 *dB(A)* in exposure level may be permitted for each halving of the duration of exposure in the U.K. In the U.S.A., Belgium, Italy and Canada an increase of 5 *dB(A)* in level is permitted for each halving of exposure time (Mulholland and Attenborough, 1981). Noise dose calculations for halving allowable exposure time differ in different countries (Wilson, 1989). Permissible noise exposures based on Occupational Safety and Health Administration (OSHA) with consideration of halving allowable exposure with each 3 and 5 *dB(A)* are shown in Table 11. Maximum level of exposure permitted without ear protection is 90 *dB(A)* for an eight-hour day or 40 hour week. In Holland the maximum level is 80 *dB(A)*, one tenth less harmful as 90 *dB(A)* (Kerr, 1979). In the U.K. the maximum level reduced to 85 *dB(A)* and it was come into force on 1st January 1990 (Health and Safety Executive, 1992). 90 *dB(A)* is the limit at which noise should ideally be reduced as a compromise between desirability and feasibility (Atherley, 1976).

Table 11 : Permissible noise exposure

(Source : Ghering, 1978).

90 dB(A) 8-hr day 5 dB trading ratio		85 dB(A), 8-hr day 5 dB trading ratio		85 dB(A), 8-hr day 3 dB trading ratio	
Duration per day (hr)	Sound level dB(A)	Duration per day (hr)	Sound level dB(A)	Duration per day (hr)	Sound level dB(A)
8	90	8	85	8	85
6	92	6	87	4	88
4	95	4	90	2	91
3	97	3	92	1	94
2	100	2	95	0.5	97
1.5	102	1.5	97	0.25	100
1	105	1	100	-------	------
0.5	110	0.5	105	--------	------
0.25	115	0.25	110	--------	------

According to the U.S. Environmental Protection Agency (EPA) the basic hearing conservation criterion is an equivalent sound level Leq < 70 *dB(A)* (based on 24-hour averaging). The EPA identified the level for activity interference and annoyance indoors in residential areas in

a day-night sound level Ldn <45 *dB(A)* (Wilson, 1989). A general level for tolerable indoor noise levels for a typical living room , is 35 *dB(A)* and for a classroom about 45 *dB(A)* (Houtgast,1980).

Noise is always present (Barrett, 1991) and the levels in the environment can be limited or reduced by noise legislation in industrially developed countries (Egunjobi, 1990). In the U.K. the Noise Advisory council recommended modification of nuisance procedures , control of noise from demolition and construction sites and introduction of noise abatement zones. These were to form the basis of the Control of Pollution Act, 1974 enacted immediately in England and Wales and in Scotland 1976 (Stiring, 1986). Noise control can be achieved mainly by planning and forethought (Mulholland and Attenborough ,1981). The first steps in any noise control procedure are the identification of the source of disturbance and the appropriate standards and laws that control the permitted noise level. Near airports it is much more difficult. The essence of successful noise control is to identify carefully the sources and path ways of the noise and then to apply the appropriate control measures at each stage (Atherley and Booth, 1974).

Noise control at source

Noise reduction at source may be accomplished by basic

acoustic machinery design, modifying existing design, muffling or changing the process entirely, but it is not always feasible (Cheremisinoff and Cheremisinoff, 1977). It is most economical and often the simplest to enclose, treat, remove, alter or otherwise quiet the source to reduce the noise problem throughout the entire area (Mulholland and Attenborough, 1981). Kerr (1979) suggested tackling noise at source by modifying or replacing noisy machinery. Often, quite trivial changes in machine design, or materials, result in large noise reductions (Atherley and Booth, 1974). In airports, jet aircraft engines produce the major portion of the noise (Meecham and Shaw, 1988). They suggest removing the source of the harmful disturbance at airport as the first sensible solution, with a) moving airports to regions distance from residents b) quiet aircraft engines, specially the jet aircraft which produce the major portion of noise.

Noise paths

If other methods fail to achieve the required reduction in sound level then noise control at path is possible by reducing the noise transmitted through the air or by increasing the distance between source and receiver by placing barriers between the source and exposed persons (Malerbi, 1989). A noise path for a vibration induced noise has three distinct stages (Althereley and Booth, 1974)

- Structure borne noise path
- Radiation of the noise from a structure into the air
-Air borne noise path

The way to reduce structure-borne noise is to isolate the noise-generating parts of machinery from the radiating surface with vibration isolators. Isolators consist of steel spring, or flexible materials like rubber or cork. Control of airborne sound from air sources is achieved by reduced air speed, adding diffusing section, removing or streamlining obstacles. For residential areas , the characteristics of buildings and the number of rooms are important for controlling the effects of the noise path (Paechter, 1988). It is effective for both internal and external noises (Vallet, et al., 1988). The physical methods of reducing noise at the paths are acoustic double glazing, the use of lead sheets, dense mineral wood, sand and vegetational sound barriers of trees, hedges and grass land (Egiunjobi, 1990). Noise reduction along noise paths is only partially effective (Mulholland and Attenborough, 1981), and offers no advantage for reducing the levels of dissatisfaction (Griffiths, et al., 1980).

Noise control at receiver (auditor)

Ear protectors are temporary measures whilst steps are taken to reduce the noise level at source (Kerr, 1979). It is not acceptable as a permanent solution to

noise problems (Cheremisinoff and Cheremisinoff, 1979). Where noise levels exceed 84 *dB(A)* no measures can be taken to reduce levels and ear defenders should be worn (Chester, 1985). The Department of Labor's Occupation Noise Standard State, emphasize that where the sound level is above 90 *dB(A)* for 8 hours-day and cannot be reduced by engineering means these administrative controls (time limits for exposure) or ear protective equipment and hearing conservation programs are required by law (Cheremisinoff and Cheremisinoff, 1977). Pre-employment and follow-up audiometric examinations should be included in a hearing conservation program (W.H.O., 1980). Ear plugs will reduce the noise level by about 20 dB, whereas well fitting ear muffs reduce the noise level by about 40 dB (Kerr, 1979).

Ear defenders are cheap, effective and the simplest solution (Cheremisinoff and Cheremisinoff, 1977). Although they are still the main way in which health related noise is controlled in factories or at airports (Cone and Hages, 1984). The ear protective devices are often not used (Cone and Hages, 1984) as they are uncomfortable, irritating and cumbersome (Cheremisinoff and Cheremisinoff, 1977).

Protective Devices

Inner ear protection plugs are designed to occlude the ear canal. They are made from soft rubber, neoprene, wax, cotton, fibreglass, or plastic (Cheremisinoff and

Cheremisinoff, 1977). Although relatively cheap, many dislike them. During insertion, dirty hands are likely to soil them, and the result is grease or dirt in the ears . Fitting is something of a problem except for the tapered or " Universal types" (Loeb, 1986). If an employee uses a helmet, he would probably be more comfortable with ear plugs . Many employees prefer to use cotton as a sound suppressor, but this is a poor alternative. Wearing ear plugs for an extended period of time may cause a "plugged" feeling, dizziness or vertigo (Cheremisinoff and Cheremisinoff, 1977). Disposable Plugs are comfortable, but require regular replacement. For occasional exposure they are cheaper, but expensive for chronic exposure. For sporadic impulsive noise or high-frequency noise, frequency-selective devices (usually plugs with an appropriate hole) may be more appropriate(Loeb, 1986).

Muffs

Muffs are more comfortable in moderate temperatures, but they are uncomfortable at high temperatures. They lose malleability and the ear seal breaks down at low temperatures. They are relatively costly but there is little problem with fit. Spring loading is necessary for a good seal with extensive use (Loab, 1986) and provide the best levels of protection (Cook, 1989). Personal hearing protectors are useful for crew or ground stuff at airports, but not for residents.

Reducing the time of exposure

Working shorter hours, providing longer or more frequent work breaks, quiet times, changing job schedules, job rotation, restricting the operation of the noise source (Kerr, 1979) are economically costly (Cheremisinoff and Cheremisinoff, 1977) may be only short term solutions.

Training employees

Those who face a risk of exposure to potentially hazardous noise level should be educated in the possible consequences of excessive noise exposure, the means and limitations of protection (W.H.O., 1980). They need to know the correct use of equipment and its locations, instructions for performing particular tasks and informing the staff of any standard noise measures (Penn, 1979).

Aircraft noise recommendations

Air travel has become a necessity for modern life where time is precious and other transport reduced or absent. Therefore, curbs on aircraft operations, despite its deleterious effects, may only prove nationally suicidal. Attempts to reduce aircraft noise or its impact

are the only ways out. Aircraft noise and related remedial measures are classified in different ways (Penn , 1979; Raney and Cawthorn, 1979; Mulholland and Attenborough, 1981; and Wells 1986) as :

Operations

a- Noise from the ground (e.g. use of buildings and vegetation as sound barrier).

b- Noise from flight operation (e.g. change flight operations)

Acoustics

The point of origin, its path and the receptor form the three dimensions of noise and intensity which can be explained by using principles of acoustics. The noise level is maximum close to the point of origin but it waves away with distance from the source.

Technicalities

A technical assessment of origin of noise from different aircraft components helps to control this problem. The aircraft produces noise through its turbo jet, turbo fan engine, airframe and propeller.

Control through technical means

a- In aircraft

Noise control at source is the cheapest and most effective method of noise control . Then sound becomes a problem as it moves away from its source .It is now a matter of concern for most airport authorities and airlines. Interest has increased with the introduction of Noise Certification in the U.K. and the U.S.A. whereby every aircraft manufactured since 1976 in the U.K. and after 1973 in the U.S.A. (or new designs since 1969) must satisfy the quality control standards on noise emission . Consequently, methods of controlling aircraft noise like insulation, aircraft and airport operating procedures, planning controls and design are examined. Improvement in the design of aircraft help in reducing the noise considerably. Modern aircraft e.g. DC-10, the quieter DC-9's, the Airbus (Table 12) are 10 to 15 *dB(A)* quieter than their predecessors (DC-8, Boeing 707) (Alexander and Barde, 1981). Attempts to reduce fan noise have concentrated primarily on altering the design of blades and covering the fan case inlet and discharge ducts with sound absorbing material. Insulating material should be porous and supported by cavities to trap sound. Improvement in compressor parts and acoustic treatment of intake ducts can be still more beneficial.

Table 12 : Aircraft noise levels at certification measurement points (source : Smith, 1989)

Aircraft type	450-m sideline	6.5-km take-off		2-km approach	
	EPNL	EPNL	dB(A)	EPNL	dB(A)
Boeing 707	115	114	104	118	105
Boeing 727	102	101	88	104	91
Boeing 737	101	96	87	102	92
Boeing 747	101	105	96	105	97
Boeing 757	94	89	71	97	86
Boeing 767	96	90	74	102	89
Douglas DC8	114	114	102	117	104
Douglas DC8-70	93	95	85	99	88
Douglas DC-9	102	97	87	102	90
Douglas DC10/MD11	98	100	90	106	94
Douglas MD80	96	90	82	93	84
Lockheed L1011	96	98	86	102	91
Airbus A300	96	91	78	102	91
Airbus A310	97	89	76	100	89
Airbus A320	93	85	72	92	81
BAe Trident	106	105	95	105	95
BAe 1-11	103	96	88	102	92
BAe 146	88	85	74	96	86
Fokker F28	100	93	79	101	93
Fokker F100	89	84	72	93	83
Concord	119	119	113	116	109
Old business jets	102	100	85	105	88
Gulfstream4	86	79	67	91	81

Introducing techniques to lower the temperature and velocity differential between the exhaust and the outside air, without adversely affecting engine performance, can considerably reduce exhaust noise. An OECD conference (May 1980) concluded that aircraft noise is likely to decrease over twenty years, because aircraft are increasingly subject to noise emission standards. New models will gradually replace the older and noisier aircraft now in use (Alexander and Barde, 1981). In the U.S.A. areas affected by aircraft noise could be reduced 50% by the year 2000.

b- On the ground

Building Insulation against some aircraft noise is possible through acoustic double glazing and replacing air bricks with mechanical ventilation systems. This is ineffective against aircraft noise which comes through the roof which should be insulated by laying lead sheets or dense mineral wool or sand over the ceiling joists of upper rooms without overloading the structure (Mulholland and Attenborough, 1981).

Studies in residential areas around Hartsfield International Airport (Atlanta, Georgia) has shown no significant association between home acoustic insulation

and annoyance (Fidell and Silvati, 1991). With double windows and a sound attenuating ventilator unit, the first-floor rooms of houses with adequately thick walls provide effective insulation against external noise of 35 to 40 dB , without loss of ventilation. U.K. grant subsidies for insulation covers up to 100 per cent of the cost around Heathrow, Gatwick, Manchester, Birmingham, Luton and four Scottish airports (Mulholland and Attenborough, 1981).

Control through planning

Aviation noise is intimately connected with land use. As distance from source is the most effective insulator against annoying sound, an aircraft operating site should be surrounded by a noise buffer area of vacant forested land. Private property near the high noise impact area.(e.g. under approach and departure paths) should be used for transportation, agriculture, manufacturing, commerce and other activities where a high level of ambient noise does not affect the performance. Many airports however, are surrounded by buildings with incompatible activities e.g. residences, schools and auditoriums. Land use controls put the burden of noise impact control on the community surrounding an airport, rather than on the airport or airport users. However, governmental policy and court decisions have required a weighting and balancing of

air transportation and air commerce objectives against the social, community, and other real interests affected by aircraft noise. The U.S. Federal Aviation Administration (FAR 150,1985b) has identified compatible land uses based on day-night sound level . These land uses, (table 13) may be compared with predicted or measured yearly average Ldn (Wilson, 1989).

The courts hold that an airport proprietor has the authority to control the location, orientation and size of the airport. The authority assumes liability for the consequences of its operation including the responsibility to protect citizens from resultant noise (Wells, 1986). Many of the noise abatement programmes (U.S.A.) permitted under current legislation are eligible for Federal Aid :
a- Take off and landing procedures to abate noise and preferential runway use to avoid noise-sensitive areas such as hospitals, educational institutions and residential areas. The zooming principle provides that, in the area of intense noise, no dwelling, schools or hospitals can be built (Egunjobi, 1990).

b- construction of sound barriers and sound proofing of buildings. One planning instrument that should be employed in attenuating noise is the use of vegetational sound barriers. This consists of spatial separation of noise sensitive land- uses from sources of noise by trees, hedges and grass (Egunjobi, 1990).

Table 13 : land use compatibility with yearly day-night average sound level (source : Wilson, 1989).

Land use	Yearly day-night average sound level (L_{DN}) (dB)					
	Below 65	65 to 70	70 to 75	75 to 80	80 to 85	Over 85
Residential						
Residential, other than mobile homes and transient lodgings	Y	N[b]	N[b]	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[b]	N[b]	N[b]	N	N
Public use						
Schools	Y	N[b]	N[b]	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[c]	Y[d]	Y[e]	Y[e]
Parking	Y	Y	Y[c]	Y[d]	Y[e]	N
Commercial use						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail—building materials, hardware, and farm equipment	Y	Y	Y[c]	Y[d]	Y[e]	N
Retail trade—general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[c]	Y[d]	Y[e]	N
Communication	Y	Y	25	30	N	N
Manufacturing and production						
Manufacturing, general	Y	Y	Y[c]	Y[d]	Y[e]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[g]	Y[h]	Y[i]	Y[i]	Y[i]
Livestock farming and breeding	Y	Y[g]	Y[h]	N	N	N
Mining and fishing, resource production, and extraction	Y	Y	Y	Y	Y	Y
Recreational						
Outdoor sports arenas and spectator sports	Y	Y[f]	Y[f]	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusements, parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

Y (Yes) Land use and related structures compatible without restrictions.

N (No) Land use and related structures are not compatible and should be prohibited.

NLR Noise level reduction (outdoor to indoor) to be achieved through incorporation of noise attenuation into the design and construction of the structure.

25, 30, or 35 Land used and related structures generally compatible: measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structure.

[a] The designations contained in this table do not constitute a federal determination that any use of land covered by the program is acceptable or unacceptable under federal, state, or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

[b] Where the community determines that residential or school uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal residential construction can be expected to provide an NLR of 20 dB, thus, the reduction requirements are often stated as 5, 10 or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

[c] Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

[d] Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

[e] Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

[f] Land use compatible provided special sound reinforcement systems are installed.

[g] Residential buildings require an NLR of 25.

[h] Residential buildings require an NLR of 30.

[i] Residential buildings not permitted.

c- Acquisition of land and interests therein , such as easements, air rights, and development rights to ensure compatible use.

d- Complete or partial curfews.

e- Denial of airport use to aircraft types or classes not meeting federal noise standards.

f- Capacity limitations based on the relative noisiness of different types of aircraft.

g- Differential landing based on FAA certificated noise levels or on time of arrival and departure.

In areas greater than 35 NNI, aircraft noise begins to become a significant reason for discontent with living conditions. In areas greater than 55 NNI, aircraft noise can be considered as intolerable . This grading of nuisance against NNI is considered carefully in the context of planning for and residential development. Planning and Noise, 1973, issued by the U.K. Department of the Environment offers guidance to planning authorities. In areas between 40-60 NNI, major residential development and hospitals should be prohibited though infill development may be allowed subject to adequate sound proofing being incorporated into the building fabric . In areas greater than 60 NNI no major residential development should be allowed (Trade and Technical Ltd, 1979). Sound insulation of roofs and windows plus mechanical ventilation should be provided for schools when the exposure is at least 35 NNI.

These guidelines have been applied around Gatwick Airport by Surrey County Council (Mulholland and Attenborough, 1981).

In the U.S.A. the use of land for residential development is only recommended if the NNI is below 38 and multiple housing is compatible if the NNI is below 55 (Trade and Technical Ltd, 1979, Mulholland and Attenbrough, 1981). According to Cone and Hages (1984) airport noise is annoying to patients and handicaps their rest and recovery. The internal noise-control recommendations include quieter heating and cooling systems and shoes that do not squeak. One other way of incorporating noise control is physical planning through Environmental Impact Assessment. EIA ensures proper assessment of new projects or changes in land-uses and their effects on human welfare and activities. The noise portion of any E.I. Statement will describe the noise environment, what changes will be brought about by the new project, and what anti-noise measures will be needed if the project were to be noise-generating (Egunjobi, 1990).

Routing, take off and landings restriction

Around Gatwick and Heathrow airports, the official policy has been to concentrate on routing. Consequently, air corridors called Minimum Noise Routes (MNRs) are aimed to minimise the numbers affected by aircraft noise rather

than reducing the sound itself. The U.K. Noise Advisory Council has opined that the scope of improvement in noise level in the vicinity of an airport through routing and take off restriction is limited. Such restrictions may adversely affect the safety of the aircrafts while landing or taking off. The specified take-off procedure is another means of noise reduction but it depends upon pilots. At Heathrow airport, it requires that aircraft should be throttled back after gaining 300 m height. The restrictions for some aircraft may include limits on fuel and numbers of passengers. A modified monitoring system has been introduced at Gatwick and are in preparation at some airports (Mulholland and Attenborough, 1981).

A very depressing phenomenon is being observed all over the world in that people are encroaching the vicinity of airports. This trend continues despite complaints of discomfort from aircraft noise. It not only exposes residents to the health hazards of aircraft noise but causes flight safety problems. Rejected food stuffs littered around airports attract the birds to human settlements which increase the chances of aircraft accidents. It starts with the connivance of concerned authorities and culminates in a major problem for the nation.

Legislative control

In the U.K., the responsibility of dealing with

aircraft noise lies with the Department of Trade and Industry. In U.S.A., is the Federal Aviation Authority and in Iran , it lies with the Ministry of Transport. The office of the Vice-president is in charge of the environment. The Iran Civil Aviation Organization has adopted the International Civil Aviation Organization (ICAO)'s regulations since the Chicago Convention (1944).

In the 47th general assembly of IATA in Nairobi on 28 and 29 October 1991, Iran suggested a resolution, despite Sanctions that all producing countries are to continue supplying parts for previously delivered civil aircraft, as well as navigation equipment without limitation or consideration to political bands. Because Iran was banned by some aircraft manufacturing countries they were not able to replace old and noisy aircrafts by new ones as I.C.A.O required. Iran had difficulty obtaining parts for aircrafts as well. This made difficulties for safety as Iran was already in the first row of countries for safety (Iran Air, 1992). The resolution strongly supports ICAO's criteria as to retiring aircraft that do not comply with new standards with a view to safety, environment and noise. Iran Air is following the ICAO's regulations.

The Chicago Convention(1944) regulates operational safety and prohibits aircraft from flying over specified areas of the United Kingdom. Section 41 of the

Act states that an Order under Section 8 may regulate the conditions under which noise and vibration caused by an aircraft on aerodromesare to be governed. Consequently, the Air Navigation Order, 1976 gives the Secretary of State power to prescribe the conditions under which noise and vibration may be caused by aircraft on government aerodromes or these owned or managed by the Civil Aviation Authority, licensed aerodromes or others which manufacture, repair or maintain aircraft by manufacturers or repairers of aircraft (Penn, 1979).

The Air Navigation (General) Regulations, 1972 specify the conditions under which noise or vibration from aircraft on aerodromes may be caused whether in the course of manufacture or since. These include: taking off or landing, moving on ground or water. Engines operate to ensure satisfactory performance, at correct temperatures and that instruments, accessories or other components of the aircraft are satisfactory . This means that noise is regulated by statutory and byelaw control (Penn, 1979). The Civil Aviation Act, 1949 and the Air Navigation Order, 1972 regulate the conditions under which noise may be caused, but neither they nor the Airport Authority Act, 1965 specify who to control aircraft noise. It is the Civil Aviation Act, 1971 which regulates aircraft noise and vibration . Powers available to the Secretary of State to regulate noise and vibration are only applicable to designated aerodromes, Heathrow, Gatwick, Stansted and

Prestwick . The Environmental Protection Act (EPA) came in force on 1st January 1991 (Barrett, 1991).

Aircraft noise at take off and landing

When the engines are at high thrust, noise rises quickly and then subsides as it spreads over a wide area during the climb. During landing and throttling back the whine of engine compressors produce the dominant sound. The rise and fall of aircraft noise as it passes overhead during landing is quicker than during take-off. The section 29 (1) of the Civil Aviation Act , 1971, clearly indicates the duties of the aircraft operator after taking off and landing and are specified in the notice to comply with limiting or mitigating the effects of noise and vibration. The noise abatement requirements at Heathrow specify minimum noise routes to be followed, and that after take-off every jet aircraft is to be operated in such a way that it does not cause more than 110 PNdB by day (defined as 0700- 2300 hours local time) or 102 PNdB by night (2300-0700 hours local time) at the relevant noise monitoring points. It requires every aircraft operator to ensure that his aircraft is always operated in a manner calculated to cause the least disturbance practicable in areas surrounding the airport (Penn, 1979).

At many airports, operators instruct their pilots to

reduce power after reaching a height of about 1000 feet and thereafter to climb less steeply under reduced power, subject to safety requirements which must always be paramount. Reduction in power after take-off reduces disturbance in residential areas crossed during the first few miles of a route, but the reduction in the rate of climb aggravates the conditions for people living further away from the airport who would be happier for aircraft to pass as high as possible over their houses. If any requirements of a notice issued under Section 29(1) are not complied with, the Secretary of State may, after considering any representations made by the aircraft operator direct the aerodrome manager to withhold facilities for using the aerodrome from the aircraft operator until such time as the direction is revoked. Additionally, if the Secretary of State decides it is necessary for the purpose of limiting or mitigating the effect of noise and vibration connected with the take-off or landing of aircraft at a designated aerodrome, he can limit the number of take-offs and landings during certain periods. Where it appears that an aircraft is about to take off flouting the Secretary of State's limitations, a person authorised by him may detain the aircraft for such a period as is considered necessary for preventing the contravention. It is possible for the Secretary of State, by written notice, to disregard any particular take off or landing. The aerodrome manager is responsible, in relation to designated aerodromes, for complying with any directions

of the Secretary of State requiring him to take steps to limit or mitigate the effect of noise and vibration associated with aircraft take-offs and landings. New regulatory proposals for all commercial aircraft, including aircraft capable of vertical take-off and landing and aircraft capable of reduced or short take-off and landing are in preparatory by the Federal Aviation Authority (U.S.A.) (Penn, 1979).

Noise monitoring

After consultation with the manager of a designated aerodrome, the Secretary of State may require him by order to provide, maintain and operate at his own expense, specified noise measuring equipment, and to provide the Secretary of State with reports of the noise measurements. At Heathrow, monitoring sites have been established for each departure route to ensure that noise levels in the first major built up areas overflown do not exceed the specified limits. Measurements are made using a system of several microphones all connected to a centralised recording unit. Before the noise monitoring points, the noise may exceed the 110 PNdB which is the maximum permissible daytime noise level at these points . Thereafter, pilots must, subject to safety considerations, continue to climb at power settings which ensure a progressive reduction in the noise level along their route. Because of these restrictions, some of the larger and

noisier aircraft are denied access to certain runways. Industrial and Marine Acoustics Ltd has announced a agreement with US-based technology integration for the U.K. support of its Airport Noise and Operations Monitoring System (ANOMS) . The system provides a powerful tool to identify whether aircraft are abiding by noise abatment procedures. It causes the reduction of disturbances that may be associated with aircraft flying incorrect departure or arrival tracks (Barrett, 1991). Some long range aircraft with large fuel supplies cannot comply when fully loaded and so reduction in fuel load may be necessary. This results in expensive and inconvenient refuelling stops due to airport landing charges and delays. Noise monitoring systems operate at Gatwick, Luton and Manchester airports.

Minimum noise routes

The Noise Advisory Council defined Minimum Noise Routes as "predetermined routes designed to direct departing aircraft, within their performance limitations, over such sparsely populated local areas as may exist". As the noise problem developed, modifications were made to routes to take advantage of open areas of ground, and to avoid areas of high population density. In other words, Minimum Noise Routes developed as a consequence of the initial need for safety. For airports close to built up areas, Minimum Noise Routes have been defined, and pilots taking off from these aerodromes are required to follow

them. These routes are not the shortest flying distances, but they are designed to ensure minimum flying over residential areas, and lead from the take-off runways to the airways which link the major airports. Although these routes are set for perfect conditions, the path followed by an aircraft is affected by the wind strength and direction.

Landing-noise control

Aircraft landing is a complicated matter with the plane flying at a relatively low height for a long time before landing. The reason for this is that aircraft have to follow radio beams and need to be stabilised during the landing process. A long straight approach is essential for this and the internationally minimum recommended descent angle is 2.5 degree. However, an approach angle of 3 degree has been widely used in the United Kingdom and other countries for many years. Trials at Heathrow and Gatwick of Continuous Direct Approach (CDA) and Low Power/Low Drag (LP/LD), offer the prospect of noticeable reductions in noise levels in communities directly under the approach path to the airport (Penn, 1979).

Runway usage

The direction of aircraft take-off or landing is governed by the speed and direction of the wind at ground

level. In the case of most aircraft it is not safe to take-off or land with a tail wind exceeding 5 knots. Within the limits of this constraint, a preferential runway system is adopted at many airports so that aircraft take-offs as far as possible over areas less likely to be affected by noise. At Heathrow, most of the aircraft take-off and land to the west, wind permitting. Other airports operate in a similar manner, with aircraft taking-off and landing in the same direction.

Aircraft stacking

Landing may have to be delayed in the case of heavy traffic and the aircraft have to circle around at different levels in what is known as a "stacking" around a radio beacon at the exits from the airway. This results in a significant number of aircraft circling in the same area and causing noise which may be the subject of complaint . This is only practised for safety reasons and occurs infrequently as it causes delays .

Engine ground running

Piston engined aircraft , need to warm up before taking-off. After routine maintenance or repair, longer running is necessary. To minimise disturbance the running up of jets takes place wherever possible using special silencers placed close to the engines.

The control of noise from ground running is the responsibility of the aerodrome owner and there are usually restrictions on the times and locations at which engines can be tested, with severe restrictions at night time. In the case of Heathrow, ground running in the maintenance areas is screened from neighbouring houses either by airport buildings or by earth banks and other specially constructed noise shields.

Aircraft noise certification

A conference in London (1966), prompted the idea of noise certification. International noise regulation and certification is the responsibility of the International Civil Aviation Organisation (I.C.A.O.) and agreed in December 1969 . The United Kingdom played a significant role in the development of international noise certification rules. These prescribe noise limits for each type of aircraft relative to its maximum certificated weight. Broadly speaking, the noise level from new types of subsonic jet aircraft is required to be about half as much, weight for weight, as earlier types (Penn, 1979). Aircraft certification issued by the Federal Aviation Authority (1969) stipulates that the maximum noise level at the prescribed measuring points directly under take-off and landing paths and a position perpendicular to the landing strip (sideline) is 108 *EPNdB* for new subsonic jet

aircraft . A further amendment in December 1974 established noise limits for small propeller-driven aircraft. Similar United Kingdom Legislation is contained in the air navigation (noise certificate) order, 1970. However, the British limits depend upon engine size and aircraft weight (Table 14) . The table shows that the newer wide-body subsonic jet aircraft (BAC 1-11, Tristar, DC-10-30) have little difficulty in meeting noise certification standards. The first certification for aircraft noise in 1969 prescribed U.S. FAA (FAR 36, 1985a) for subsonic sideline (regardless of number of engines) 103 *EPNdB* for maximum weights of 882,000 lb or more, reduced by 2.56 *EPNdB* per halving of weight down to 94 EPNdb for 77,200 lb or less (Wilson, 1989). For approaches, (regardless of number of engines) 105 *EPNdB* for maximum weights of 617,300 lb or more reduced by 2.33 *EPNdB* for halving of weight down to 98 *EPNdB* for 77,200 lb for propeller-driven small airplanes. FAR 36 (FAA, 1985a) limits A-weighted sound for recent-designed small propeller aircraft to 68 *dB(A)* for aircraft weight <1320 lb (600 kg), increasing at a rate of 1 *dB(A)*/165 lb [1 *dB(A)* / 75 kg] for weights above 1320 lb, but not exceeding 80 *dB(A)* for weights between 3300 and 12500 lb inclusive (Wilson, 1989). Federal Aviation Regulations (FAR) part 91 sub part E sets a timetable of dates for compliance and calls for retirement or retrofit of aircraft (both foreign and domestic) that do not comply with FAR part 36 by 1985 (Wells, 1986).

Table 14 : Airline noise data(noise level in EPNdB)

(source: Mulholland and Attenborough, 1981)

Aircraft	Gross weight/lb	Take-off noise		Sideline noise		Approach noise	
		Measured NC*		Measured NC*		Measured NC*	
Aerospatiale Carvel 12 Aeropatiale/B AC	127870	94	96	102	103.5	104	107
Concorde	389000	114	105	111	107	115	107
BAC One-eleven 475	92000	96	95	108	103	103.5	103
BAC Super VC 10	335000	110	104	113.5	106.5	115	106.5
Boeing 707-320 B/C	333600	112	104.2	102.8	106.5	115.7	106.5
Lockheed Tristar	430000	96	105.5	95	107	103	107
McDonnell Douglas	325000	117	103.5	103	106.5	117	106.5
DC-8 DC-10-30	555000	104	107.5	97	108	107	108

*NC= noise level required for noise certification

At present, supersonic aircraft are not controlled by noise regulations although during the design stage of Concorde the target for noise production was the level of comparable subsonic jets. However, the older subsonic jet aircraft are gradually being replaced by quieter aircraft. Restrictions apply to the U.S. operations of the excepted British-French concord : which may not be modified in any way which increases their noise levels. Scheduled operations at U.S. airports are prohibited between 10 pm and 7 am and SST'S are prohibited from causing sonic booms in the United State When flying to or from U.S airports (Wilson, 1989).

The international noise certification scheme was implemented in the U.K. by the Air Navigation (Noise Certification) Order, 1970. The Order prohibits any aircraft requiring a noise certificate from taking off or landing in the United Kingdom unless there is a current noise certificate and any conditions attached to it complied with (Penn, 1979).

Since September 1970 an International Committee on Aircraft Noise (CAN) has met approximately every 18 month to consider proposed aircraft noise standards presented by its various international working groups. The United Kingdom is represented on the I.C.A.O. council, CAN, and on all the international working groups who meet regularly to consider noise standards for various types of aircraft.

Iran, as a member, is following the ICAO's regulations and has been asked to replace noisy old aircraft with new quieter ones (Kayhan Havai, 1993).

Because of the international nature of air transport, it is important to try and achieve reductions in aircraft noise on an international basis.

Cost of reducing aircraft noise

An aircraft manufacturer faced with noise certification procedures can choose between a new design of fuselage, wing shape and position so as to shield the ground beneath from engine noise. A new type of "quiet engine" such as the RB211, or a refit or hush-kitting of an existing aircraft are the possible alternatives. The costs of new design are exorbitant and even hush-kits can cost up to $4 million per aircraft.

The cost of noise reduction and the benefits of a noisy product process to the noise producer, which might be of the order of thousands of pounds (Mulholland and Attenborough, 1981). Governments may elect to reduce noise around its airports by impressing on airlines the need to use the quieter types of aircraft or by instituting "minimum" noise routes and take-off and landing procedures. Noise reduction requires expensive monitoring and enforcement procedures. Increased flight staff payments may be needed if safety regulations are modified.

European airports have provided the leadership in establishing noise-based charges (Nelson, 1987). The basic philosophy is that the aircraft operators should pay a fee proportionate to the noise they generate. The operators of noisier aircraft are financially penalized while the operators of quieter aircraft are awarded by reduced landing charges. At present there are at least 27 European airports with some noise-based charge system in operation. Aircraft noise charge schemes exist now in the Netherlands, France, Switzerland, Japan, U.K. and Germany (Nelson, 1987). For example, in Geneva and Zurich (Switzerland) the noisiest aircraft, which include the DC-8 series 20-40, currently pay 400 Swiss Francs per operation. Wide-bodies (e.g. Airbus A-300, Boeing 757-767) current technology aircraft, in contrast are not required to pay any noise surcharge. Improved design of Boeing 757 and 767 aircraft engines reduces the noise considerably (Tables 12 and 15). However, further large-scale reduction in aircraft noise will not be possible (Wells, 1986). Noise abatement procedures and special operational restrictions have resulted in substantial noise reduction from existing airports. Germany and Great Britain take a different approach. In the U.K. the normal landing charges is 15% at London Airports, 10% at Manchester to aircraft that comply with the International Civil Aviation Organization (ICAO) noise standards. The estimate of direct total of such charges for British Airway in 1990-91 was £3 million

Table 15 : Turbojet powered aircraft (source : Depart ment of Transport, 1991).

Make/ model	Engine model	M.T.O.W. (Lbs/ 1000)*	Noise levels EPNdB**		
			Take-off	Approach	sideline
Boeing B-767-300	CF6-80A2	351	91.2	101.7	96.5
Boeing B-767-300	CF6-80C2-B4	380	90.2	96.5	95.3
Boeing B-767-300	CF6-80C2-B4	407	92.1	98.4	95.2
Boeing B-767-300	CF6-80C2-B6	380	89.2	96.5	96.4
Boeing B-767-300	CF6-80C2-B6	407	91.1	98.4	96.3
Boeing B-767-300	JT9D-7R4D(B)	300	91.0	102.3	95.7
Boeing B-767-300	JT9D-7R4D(B)	351	95.7	103.0	95.4
Boeing B-767-300	JT9D-7R4E	300	90	102.3	96.5
Boeing b-767-300	JT9D-7R4E	351	95.0	103.0	96.2

* Maximum take-off weight

** Effective Perceived Noise Decibel

(British Airways, 1992). This includes outstanding charges for Bac 1-11 400 series aircraft the last of which were sold in october 1988. In Germany reduction of landing charge for aircraft complying with ICAO is 18 to 21% (Nelson, 1987). In France, a charge of one franc per passenger on domestic flights and of three francs for international flights has been levied since 1973 at Orly, Charles de Gaulle airports (Paris). It was decided in 1983 to link the landing fee with the noise levels emitted by aircraft. Aircraft classified in one of five noise groups. The quietest paying the nominal landing fee minus 10%, group 4 paying the nominal fee, group 3 paying landing fee plus 5%, group 2 paying landing fee plus 10% and group 1 paying fee plus 20% (Nelson, 1987). The proceeds are used to sound proof buildings affected by airport noise (Alexander and Barde, 1981). In the Netherlands a charge scheme on aircraft noise was put into force in 1983. the charge for acoustically certified aircraft (Nelson, 1987). In Japan special landing fee designed to finance noise abatement has been charged since September 1975 (Nelson, 1987).It is based on the weight of the aircraft and its sound level landing and take off. The Japanese Ministry of Transport surcharges jet aircraft passengers to cover the cost of implementing its noise-abatement programme. The level is at an average rate of $2 per head but varies according to the noise level of aircraft type using Tokyo, Osaka, Nagoya and Fukuoka airports (Mulholland and

Attenborough, 1981). Between 1973 and 1979 noise charges in France totalled 160 million Francs and in Japan in 1978 fiscal year up to US $ 95 millions (Alexander and Barde, 1981)

Federal funds are available to assist airports in sound proofing buildings or buying noise-impact land, usually these are extremely expensive remedial measures. In many cases, airports have had to pay nuisance and damage claims for noise. They reduce their liability and to protect themselves institute noise abatement programs for restricting aircraft flight paths or hours of operation to reduce noise impact on residential areas. Noise abatement procedures have a detrimental effect on airport capacity. Many airports with serious congestion and delay have found that the need to control noise restricts their freedom of action (Wells, 1986). Manchester Airport has developed a noise control programme which is the most comprehensive of its kind in Britain (Manchester Airport, 1992,a). It has recently invested £1.5 million in an engine run up designed to reduce the disturbance caused when aircraft engines have to be tested following engineering work. The installation of this equipment has resulted in a reduction of 80% .In some cases, airports have had to purchase surrounding land or install noise-absorbing insulation in buildings under flight paths (Wells, 1986). Manchester airport provided grants for insulating affected homes which cost the airport £1,000,000 per year

(Manchester airport, 1992,b). In addition the recent purchase of a £200,000 computer will ensure that, where possible, aircraft will route away from the centres of population. The federal governments should set and enforce uniform national standards for aircraft noise. However, U.S.A. (FAA) has been reluctant to embark on such a policy, in part because the federal government might then have to assume liability for violations of the standard (Wells, 1986). Frankfurt (Germany), awards premiums to airlines operating quiet aircraft (Mulholland and Attenborough, 1981).

Airport layout design directs the noise away from built up areas. It is part of noise reducing which requires careful analysis, development of proper land use, and a coordinated approach by the government, aircraft manufacturers, airport operators and the community (Wells, 1986).

Health recommendation

Although noise cannot be eliminated (Mulholland and Attenborough, 1981; Barrett, 1991) it has to be moderated to reduce the risk to human life. The medical effects of aircraft noise are demonstrated at a level above NNI=33. Lower ranges are not necessarily safe for people, so

aircraft noise in residential areas should not exceed NNI=20 (Knipschild, 1977).

To reduce both subjective disturbance and the health risk, maximal permissible overflight sound level should be 115 *dB(A)* with maximal permissible sound level of acceleration kept less than 60 dB/s (Ising, et al., 1990). The same energy equivalent sounds pressure level (Leq) disturbance caused by military low-altitude flight noise is essentially greater than civil aircraft (Ising, et al., 1990) . Military flights should avoid residential areas as acoustic insulation is effective for street traffic noise but not for aircraft noise (Fidell and Silvati, 1991). Because people sleep badly in the presence of noise, indices can be used to determine criteria to protect sleep (Nelson, 1987).

Environment has been widely appreciated as a critical variable of human growth, development, health and happiness (Sahay, 1990). More effort is needed to create a better environment by reducing noise and its effects. This is important for policy and planning as well as understanding, in psychological terms, the effects of change in environment (Griffiths and Raw, 1986).

Further research into psychological and physiological effects of noise, especially the relationship between noise and psychiatric diseases is needed because people cannot

become accustomed to aircraft noise. The 5-year plan for construction and siting of new airports in Iran should therefore avoid planning airports near residential areas. Iran has given attention to improving health criteria, is one of the first developing countries to adopt the W.H.O. goal of " health for all by the year 2000" (Gann, 1986). Airport noise need to be taken into consideration regarding its effect on the psychosocial health of the community.

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APPENDICES

APPENDIX A.

Some typical noise indices (source : Smith, 1989)

Noise and number index: NNI – The NNI is of British origin and was probably the first noise exposure index to address the aircraft noise issue. It is based on the average (peak) perceived noise level over the daytime period 0700–1900, in the three summer months. It allows for the number of operations (N) by adding $15 \log_{10} N$. It only includes events above 80 PNdB, a level that is considered to be the threshold of annoyance.

Isopsophic index: I – This French index is similar in concept to the NNI, but it covers a twenty-four-hour period with a night-time weighting of 6 or 10 dB, depending on the frequency of operations.

Day/night equivalent sound level: DNL *or* L_{DN} – This is an L_{eq}-type, dBA-based rating that is unique to the United States. The energy is averaged over a twenty-four-hour period but night-time events are weighted by the addition of 10 dBA.

Hourly noise level: HNL – Another U.S. (Californian) index, the HNL is based on the noise energy measured over the period of one hour.

Community noise equivalent level: CNEL *or* L_{CNE} – This is a variant on the DNL. It originated in California and was subsequently adopted by Denmark. Like the DNL, it makes use of the dBA, but with a night-time penalty of 10 dBA and also an evening weighting of 5 dBA.

Total noise load *or* Kosten unit: B – This is a rating developed in the Netherlands and is based on dBA. It subdivides the twenty-four-hour period into nine units, with a variety of weighting factors, depending upon sampled community response.

Noise exposure forecast: NEF – This was developed in the United States and was used by the federal auhorities for many years in developing airport noise policies. It was based on the EPNL and drew a distinction between day and night-time operations.

Composite noise rating: CNR – The CNR is an NNI-type unit based on peak PNdB, but with a 13-dB night weighting.

Day/evening night level: DEN *or* L_{DEN} – This is a Danish unit, which, like the CNEL, is based on dBA but draws three distinctions – day, evening and night.

Equivalent level: L_{eq}(A) – This is the unit recommended by the EEC, being a dBA-based L_{eq} derivative that can either be used on a twelve- or twenty-four-hour basis (with different normalisation corrections).

Storindex: Q – This is an L_{eq}-type unit that has a 5-dB weighting for night-time operation and finds favour in the Federal Republic of Germany. An Austrian version uses a 10-dB night weighting.

Weighted equivalent continuous perceived noise level: WECPNL *or* L_{WECPN} – This is the unit that was originally recommended by ICAO for international harmonisation purposes. It is based on the EPNL and draws a distinction between day and night. In practice, it has found little favour other than in Japan, where it is used in a modified form, and in Italy and Brazil.

Appendix B : (Questionnaires)

1-Teachers Response (Questionnaire)

Male/Female.....years of service.....

years of service at this school.....

1 - Are you living in this area? (1 code)

[] yes 1

[] no 2

2 - Do you enjoy aircraft noise? (1 code)

[] very much 1

[] fairly 2

[] a little 3

[] no 4

3 - Does aircraft noise force you to abandon a lesson or activity? (1 code)

[] very often 4

[] fairly often 3

[] occasionally 2

[] no 1

4 - Does aircraft noise effect your performance in class? (1 code)

[] yes 2

[] no 1

5 - Do you have to make any changes whilst teaching during aircraft noise? (1 code)

[] yes 2

[] no 1

6 - If so, which? (5 code)

[] stop teaching until noise ends 1

[] raise your voice whilst you are teaching 2

[] close windows 3

[]look for alternative accommodation and cancel classes 4

[] others 5

7 - Which problems does aircraft noise make for you?

[] speech interference 1

[] teaching interference 2

[] forget subjects or labratory activity 3

[] alter the way you teach 4

[] pupils become noisier 5

[] pupils become less inclined to work 6

8 - How much are you annoyed by aircraft noise? (1)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

9 - Does aircraft noise cause you more tiredness at the end of day? (1 code)

[] very often 4

[] quite often 3

[] rarely 2

[] not at all 1

10 - Does aircraft noise give you headaches? (1 code)

[] very often 4

[] quite often 3

[] occasionally 2

[] not at all 1

11 - Would you like to change this place of teaching? (1)

[] yes 2

[] no 1

12 - If so, what are your main reasons? (3 code)

.....

.....

.....

13 - How much are you annoyed by road traffic noise?

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

14 - Have you ever seen any unexpected behaviour in your pupils? if yes, please describe it (6 code)

.....

.....

.....

15 - Did aircraft noise cause some problems that we did not ask you about? if yes, please describe. (6 code)

.....

.....

.....

2-Response of residents in the vicinity of airport (questionnaire)

Age.....Male/Female.....Occupation.....

Married/Single.....No.of Family members.....

Income per month.....Education level.....

1- Is there any thing you particularly like about living in this area? (6)

.....

.....

2- Is there any thing you particularly dislike about living in this area ? (6)

.....

.....

3-How satisfied are you with this area as a place to live in?

[] very satisfied 1

[] Fairly satisfied 2

[] Rather dissatisfied 3

[] Very dissatisfied 4

4- How long have you lived in this area ? (1)

[] Under six months 1

[] Six to eleven month 2

[] 1 year to 1.5 years 3

[] 2 years to 4.5 years 4

[] 5 years to 9.5 years 5

[] 10 years or more 6

[] Always/all my life 7

5- Would you like to move from this house? (1 code)

[] Yes, would like to move somewhere else in this area 1

[] Yes, would like to move out side this area 2

[] No , I would not 3

6 - If want to leave, reasons for it? (6)

.....

.....

.....

7 - How satisfy are you with the amount of noise here from Cars, Lorries or other road traffic ? (1 code)

[] definitely satisfied 1

[] fairly satisfied 2

[] rather unsatisfied 3

[] definitely unsatisfied 4

8 - How satisfy are you with the amount of noise here from aircraft? (1 code)

[] definitely satisfied 1

[] fairly satisfied 2

[] rather unsatisfied 3

[] definitely unsatisfied 4

9-When you are indoors which of these noises do you hear?

[] Cars, lorries and other road traffic 1

[] Trains 2

[] Aircraft 3

[] Factories or machinery 4

[] Building works 5

[] Children or other people outside 6

[] Neighbours 7

[] any other noises 8

10- Which noise is the biggest nuisance to you? (1)

[] Road traffic 1

[] Trains 2

[] Aircraft 3

[] Factory or machinery 4

[] Children or other people outside 5

[] definitely satisfied 1

[] fairly satisfied 2

[] rather unsatisfied 3

[] definitely unsatisfied 4

8 - How satisfy are you with the amount of noise here from aircraft? (1 code)

[] definitely satisfied 1

[] fairly satisfied 2

[] rather unsatisfied 3

[] definitely unsatisfied 4

9-When you are indoors which of these noises do you hear?

[] Cars, lorries and other road traffic 1

[] Trains 2

[] Aircraft 3

[] Factories or machinery 4

[] Building works 5

[] Children or other people outside 6

[] Neighbours 7

[] any other noises 8

10- Which noise is the biggest nuisance to you? (1)

[] Road traffic 1

[] Trains 2

[] Aircraft 3

[] Factory or machinery 4

[] Children or other people outside 5

[] Children or other people in your home 6

[] Neighbours 7

[] House hold appliances(e.g.Hoovers,Washing machines) 8

[] Any other noises 9

11 - How much are you annoyed by Cars, Lorries and other road traffic noise? (1)

[] very much 4

[] Fairly 3

[] A little 2

[] Not at all 1

12-When you are at home, does traffic noise ever(if yes) (7)

[] Startle you? 1

[] Wake you up? 2

[] interfere with listening to radio or T.V. 3

[] make the T.V. picture flicker? 4

[] make the whole house vibrate? 5

[] interfere with conversation? 6

[] make you feel tense and edgy? 7

13 - How much are you annoyed by Train noise? (1)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

14 - How much are you annoyed by Aircraft noise? (1)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

15 - Do you enjoy Aircraft noise? (1)

[] yes, very much 1

[] yes, fairly 2

[] yes, a little 3

[] no 4

16- When you hear the Aircraft fly over head, do you ever feel the danger of a crash? (1)

[] yes, very often 1

[] yes, fairly often 2

[] yes, occasionally 3

[] no 4

17 - When you are at home, which of the following is effected by aircraft noise? (7)

[] startling affect 1

[] sleep 2

[] Audibility of radio or T.V. 3

[] T.V. picture flicker 4

[] make the whole house vibrate 5

[] interfere with conversation 6

[] make you feel tense and edgy 7

18 - During the last month which of the following is effected by Aircraft noise? (11)

[] headaches 1

[] feel nervous 2

[] difficulty to get to sleep 3

[] awakened during the night 4

[] palpitations or thumping heart 5

[] irritable or short-tempered 6

[] feel undue tiredness or fatigue 7

[] a feeling of sadness or depression 8

[] feel eye trouble 9

[] faintness or dizziness 10

[] forced you to take pills for your nervous or to get to sleep 11

19- Do you think that noise threatens people's health?(1)

[] very much 4

[] fairly 3

[] a little 2

[] no 1

20 - How much are you bothered by noise in general ? (1)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

21 - how do you rate yourself for sensitivity to noise? (1)

[] more 1

[] less 2

[] like others 3

[] don't know 4

22 - How has been your health during last month? (1)

[] very good 1

[] good 2

[] average 3

[] poor 4

[] very poor 5

23- During the last month how has road traffic noise affected you? (11)

[] gave you headache 1

[] feel nervous 2

[] difficulty to get to sleep 3

[] awakened during night 4

[] palpitations or thumping heart 5

[] irritable or short-tempered 6

[] feel undue tiredness or fatigue 7

[] a feeling of sadness or depression 8

[] feel eye trouble 9

[] faintness or dizziness 10

[] forced you to take pills for your nervous or to get to sleep 11

24 - are you: (1)

[] working at Mehr Abad Airport 1

[] working with company connected with airport 2

[] neither 3

25 - How long have you been in your present job?(1)

[] less than 6 month 1

[] 6 to 11 month 2

[] 1 to 4.5 years 3

[] 5 to 10 years 4

[] more than 10 years 5

26 - How much are you bothered by noise at work(while you are working)? (1)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

27 - Would you say that the noise at your working place is:

[] a lot more than home 1

[] a little more than home 2

[] about the same as at home 3

[] a little less than home 4

[] a lot less than home 5

28 - During the last month, did you have ? (20)

[] a sore throat 1

[] breathlessness 2

[] constipation or diarrhoea 3

[] nausea or vomiting 4

[] indigestion 5

[] eye strain /other eye trouble 6

[] faintness or dizziness 7

[] headache 8

[] loss of appetite 9

[] irritation / short-tempered 10

[] pain in chest 11

[] backache 12

[] ache in joints, legs, muscles or arms 13

[] palpitations or thumping heart 14

[] sores, ulcers, rashes or other skin troubles 15

[] nightmares 16

[] burns, bruises, cuts or other accidents 17

[] undue tiredness or fatigue 18

[] hearing a ringing in your ears 19

[] high blood pressure 20

29- Which problems, you earlier had ? (20)

[] a sore throat 1

[] breathlessness 2

[] constipation or diarrhoea 3

[] nausea or vomiting 4

[] indigestion 5

[] eye strain / other eye trouble 6

[] faintness or dizziness 7

[] headache 8

[] loss of appetite 9

[] irritation /short-tempered 10

[] pain in chest 11

[] backache 12

[] ache in joints,legs,muscles or arms 13

[] palpitations or thumping heart 14

[] sores, ulcers, rashes or other skin trouble 15

[] nightmares 16

[] burns, bruises, cuts or other accidents 17

[] undue tiredness or fatigue 18

[] a ringing in your ears 19

[] high blood pressure 20

30 - Have you ever seen a psychologist, psychiatrist or psychoanalyst as a patient? (1)

[] yes, during last month 3

[] yes, before the last month 2

[] never 1

31 - Have you ever seen an Ear, Nose and Throat specialist for ear problem? (1)

[] yes, during last month 3

[] yes, before the last month 2

[] never 1

32 - Do you have difficulty getting to sleep? (1)

[] yes 2

[] no 1

33 - If so, what are the main reasons? (3)

.....

.....

34 - Do you wake up during the night? (1)

[] yes 2

[] no 1

35 - If so, what are the main reasons? (3)

.....

.....

.....

36 - What do you do to help you get the sleep? (3)

.....

.....

.....

37 - Do you sleep with windows open or closed in summer?(1)

[] open 1

[] closed 2

38 - If (closed), what is the reasons for that? (3)

.....

.....

.....

39- Do you sleep in front or the rear of the dwelling?1)

[] front 1

[] rear 2

40 - Do you have any children? (1)

[] yes 2

[] no 1

41 - If yes, are they affected by noise? (4)

[] very much 4

[] fairly 3

[] a little 2

[] not at all 1

42 - Which noises do your children fear? (4)

[] aircraft 4

[] train 3

[] road traffic 2

[] none of them 1

43 - Do your children lose sleep? (1)

[] yes 2

[] no 1

44 - If so, what are the main reasons? (3)

.....

.....

.....

Appendix C (questionnaires in Farsi)

پرسشنامه برای مدرّسین اطراف فرودگاه مهرآباد

بسمه‌تعالی

برادر
خواهر محترم سلام علیکم

پرسشنامه پیوست بخشی از یک تحقیق در رابطه با بهداشت عمومی است . پاسخ درست و دقیق به سوالات مطرح شده شخصیت اجتماعی شماست و از اینکه مقداری از وقت خود را به این امر اختصاص می دهید کمال تشکر را داریم . خواهشمند است بفرمائید بعضی از سوالات چند جوابی ممکن است لازم باشد بیش از یکمورد علامت زده شود و در رابطه با سوالات تشریحی لطفا" خیلی مختصر پاسخ داده شود . ضمنا" اطلاعات ارائه شده کاملا" محفوظ و در صورت تمایل می توانید از ذکر نام و نام خانوادگی خودداری فرمائید .

نام و نام خانوادگی جنس سابقه تدریس به سال سابقه تدریس دراین آموزشگاه

۱ـ آیا شما در همین منطقه زندگی می کنید ؟

( ) ۱ـ بله ( ) ۲ـ خیر

۲ـ آیا شما از صدای هواپیما لذت میبرید ویا برایتان جالب است

( ) ۱ـ بله ( ) ۲ـ خیر

۳ـ آیا هرگز سروصدای هواپیما باعث شده‌است که شما درس یا فعالیت خود را رها کنید ؟

( ) ۱ـ خیر ( ) ۳ـ نسبتا" زیاد

( ) ۲ـ بله گاهگاهی ( ) ۴ـ خیلی زیاد

۴ـ آیا صدای هواپیما باعث می‌شود که‌شمابه عنوان یک مدرّس کمتر موءثر باشید ؟

( ) ۱ـ بله ( ) ۲ـ خیر

۵ـ آیا در خلال سروصدای هواپیما شما مجبور شده‌اید تغییری در تدریس خود داشته‌باشید ؟

( ) ۱ـ بله ( ) ۲ـ خیر

. اگر بله ـ کدام موارد زیر ؟

) ۱ـ متوقف کردن تدریس تا صدای هواپیما قطع شود

) ۲ـ صدای خود رابلند می‌کنید در حالی که درس می‌دهید

) ۳ـ پنجره‌های کلاس را می بندید

) ۴ـ چاره کار را در تعطیل کردن کلاس می‌دانید

) ۵ـ موارد دیگر

ـ سروصدای هواپیما کدام مشکلات رابرایتان ایجاد می کند ؟

) ۱ـ مزاحمت در صحبت کردن ( ) ۳ـ باعث فراموشی موضوع تدریس یا فعالیت آزمایشی می‌شود

) ۲ـ مزاحمت در تدریس کردن ( ) ۴ـ باعث تغییر روش تدریس شما می شود

) ۵ـ باعث می شود که دانش آموزان . در کلاس شلوغ بازی و سروصدا کنند .

) ۶ـ باعث می شود که دانش آموزان کمتر تمایل و توجه به‌کار داشته‌باشند .

چقدر خود شما از سروصدای هواپیما ناراحت می‌شوید ؟

) اصلا" ناراحت نمی شوم ( ) ۳ـ نسبتا" باعث ناراحتی من می‌شود

) ۲ـ کمی ایجاد ناراحتی می‌کند ( ) ۴ـ خیلی زیاد ناراحت می‌شدم .

آیا سرو صدا ی هواپیما باعث می‌شود که شما در پایان تدریس بیشتر احساس خستگی کنید

) ۱ـ خیر ابدا" ( ) ۳ـ نسبتا" زیاد

) ۲ـ بله کمی ( ) ۴ـ بله خیلی زیاد

یا سروصدای هواپیما باعث می‌شود که‌شما سردرد بگیرید

) ۱ـ ابدا" ( ) ۳ـ بله نسبتا" زیاد

) ۲ـ گاهگاهی بله ( ) ۴ـ بله خیلی زیاد

یا شما دوست دارید که محل تدریس خود را در اینجا تغییر دهید ؟

) ۱ـ خیر ( ) ۲ـ بلـه

۱۲ـ اگر بله ـ دلایل اصلی شما چیست ؟

۱۳ـ چقدر سروصدای اتومبیلها باعث ناراحتی جنابعالی می شود ؟

( ) ۱ـ ابدا" باعث ناراحتی نمی‌شود ( ) ۳ـ نسبتا" زیاد باعث ناراحتی می‌شود

( ) ۲ـ کمی ایجاد ناراحتی می کند ( ) ۴ـ خیلی زیاد ایجاد ناراحتی می‌کند

۱۴ـ آیا هرگز شما رفتار غیر قابل انتظار ی در شاگردان خود مشاهده نموده‌اید ؟ اگر بله لطفا" شرح بفرمائید ؟

۱۵ـ آیا سروصدای هواپیما باعث مشکلاتی می شود که ما سوءال نکرده‌ایم ؟ لطفا" در صورت مثبت بودن جواب شرح دهید ؟

بسمه‌تعالی

برادر / خواهر محترم سلام علیکم

پرسشنامه پیوست بخشی از یک تحقیق در رابطه با بهداشت عمومی است . پاسخ درست و دقیق به سوالات معرف رشد شخصیت اجتماعی شماست و از اینکه مقداری از وقت خود را به این امر اختصاص می دهید کمال تشکر را داریم . توجه بفرمایید بعضی از سوالات چند جوابی ممکن است لازم باشد بیش از یک مورد علامت زده شود و در رابطه با سوالات تشریحی لطفا" خیلی مختصر پاسخ داده شود . ضمنا" اطلاعات ارائه شده کاملا" محفوظ و در صورت تمایل می توانید از ذکر نام و نام خانوادگی خودداری فرمائید .

پرسشنامه جهت ساکنین اطراف فرودگاه مهرآباد

نام — نام خانوادگی — شغل — جنس — محل تولد

وضعیت تاهل — تعداد افراد خانواده — میزان تحصیلات — درآمد ماهانه

۱ـ چه چیز خاصی باعث شود شما دوست داشته باشید دراین محل زندگی کنید ؟ (لطفا" توضیح دهید)

۲ـ چه چیزخاص وجود دارد که شما دوست نداشته باشید در این محل زندگی کنید ؟

۳ـ چقدر شما نسبت به این منطقه به عنوان محلی برای زندگی رضایت دارید .

( ) ۱ـ خیلی رضایت دارم ( ) ۲ـ تقریبا" ناراضی هستم

( ) ۲ـ نسبتا" راضی هستم ( ) ۲ـ خیلی ناراضی هستم

۴ـ چه مدت شما در این منطقه زندگی کرده‌اید .

( ) ۱ـ کمتر از ۶ ماه
( ) ۲ـ " " ۱۱ـ۶ ماه
( ) ۳ـ کمتر از ۱/۵ـ۱ سال
( ) ۴ـ " " ۲/۵ـ۲ "
( ) ۵ـ " " ۹/۵ـ۵ سال
( ) ۶ـ " " ۱۰ سال یا بیشتر

۵ . آیا دوست دارید از اینجا نقل مکان کنید ؟

( ) ۱ـ بله . راضی هستم جای دیگر در همین منطقه زندگی کنم .
( ) ۲ـ بله . دوست دارم به خارج از این منطقه نقل مکان کنم .
( ) ۳ـ خیر دوست ندارم

۶ـ اگر راضی هستید نقل و مکان کنید لطفا" دلایل اصلی خودتان را بیان فرمائید ؟

۷ چه احساسی نسبت به مقدار سر و صدا ی اتومبیل ها و کامیونها وسیر رفت وآمدهای جاده و خیابان دارید

( ) ۱ـ کاملا" رضایت بخش است
( ) ۲ـ نسبتا" رضایت بخش است
( ) ۳ـ تقریبا" راضی نیستم
( ) ۴ـ کاملا" ناراضی هستم

۸ـ چه احساسی نسبت بدمقدار سروصدای هواپیما ها دارید ؟

( ) ۱ـ کاملا" رضایت بخش است
( ) ۲ـ نسبتا" رضایت بخش است
( ) ۳ـ تقریبا" ایجاد نارضایتی می‌کند
( ) ۴ـ کاملا" نارضایتی ایجاد می‌کند

۹ وقتی شما در منزل هستید کدامیک از سروصدا های زیر را می‌شنوید ؟

( ) ۱ـ اتومبیل ، کامیون وسایر رفت آمدهای جاده‌ای
( ) ۲ـ قطار
( ) ۳ـ هواپیما
( ) ۴ـ کارخانه‌ها و کارگاهها
( ) ۵ـ کارهای ساختمانی
( ) ۶ـ بچه‌ها و افراد بیرون
( ) ۷ـ همسایه‌ها
( ) ۸ـ سروصداهای دیگر

۱۰ کدامیک از موارد زیر بیشترین سروصدا و ناراحتی را برای شما ایجاد می‌کند .

( ) ۱ـ رفت و آمد جاده ها و خیابانها
( ) ۲ـ قطار
( ) ۳ـ هواپیما
( ) ۴ـ کارخانه و کارگاهها
( ) ۵ـ بچه‌ها و افرادی که خارج از خانه هستند
( ) ۶ـ بچه‌ها و افراد داخل منزل
( ) ۷ـ همسایه‌ها
( ) ۸ـ وسایل خانگی مانند جارو برقی و ماشین لباس
( ) ۹ـ سروصدا های دیگر

۱۱ سروصدا کاتومبیل ها و کامیونها وسایر رفت وآمدهای جاده‌ای چقدر باعث آزار و اذیت شما می شود

( ) ۱ـ ابدا" باعث اذیت من نمی شود
( ) ۲ـ کمی ایجاد ناراحتی میکند
( ) ۳ـ نسبتا" ایجاد ناراحتی می کند
( ) ۴ـ خیلی زیاد باعث آزار و ناراحتی می شود

۱۲ وقتی شما در خانه هستید آیا سروصدا ی ناشی از اتومبیلها موارد زیر را در شما ایجاد می‌کند ؟ اگر بله لط
موارد را علامت بزنید .

( ) ۱ـ باعث از جا پریدن ناگهانی می‌شود
( ) ۲ـ باعث می‌شود از خواب بیدار شوید
( ) ۳ـ باعث مزاحمت برای گوش‌دادن به رادیو و تلویزیون می‌شود .
( ) ۴ـ باعث تکان خوردن و خراب شدن تصویر تلویزیون می شود
( ) ۵ـ باعث لرزش در آوردن خانه می‌شود
( ) ۶ـ مانع صحبت کردن و گفتگو می‌شود
( ) ۷ـ باعث هیجان و تنش می‌شود .

۱۳ سروصدا ی قطار تا چه حد باعث ناراحتی و آزار شما می‌شود ؟

( ) ۱ـ اصلا" باعث آزار و اذیت من نمی شود
( ) ۲ـ کمی باعث آزار و اذیت من می شود
( ) ۳ـ نسبتا" زیاد باعث ناراحتی من می‌شود .
( ) ۴ـ خیلی زیاد باعث آزار و اذیت من می‌شود

۱۴ سروصدا ی هواپیما چقدر باعث اذیت و آزار شما می‌شود ؟

( ) ۱ـ اصلا" ایجاد ناراحتی نمی‌کند
( ) ۲ـ کمی باعث اذیت و آزار من می‌شود
( ) ۳ـ نسبتا" زیاد ایجاد ناراحتی می‌کند
( ) ۴ـ خیلی زیاد باعث آزار و اذیت من می‌شود

۱۵.آیا شما از سروصدا ی هواپیما لذّت می برید و یا برایتان جالب است ؟

( ) ۱ـ بله خیلی زیاد ( ) ۳ـ بله کمی

( ) ۲ـ بله نسبتا" ( ) ۴ـ خیـــــر

۱۶ـوقتی که سرو صدای هواپیما را در بالا هنگام پرواز می شنوید آیا احساس می‌کنید که خطر و یا برخورد ی متوجه شما خواهد بود؟

( ) ۱ـ بله خیلی زیاد ( ) ۳ـ گاهگاهی بله

( ) ۲ـ بله نسبتا" زیاد ( ) ۴ـ خـــــیر

۱۷ـ وقتی شما در خانه هستید، سرو صدای هواپیما کدام موارد زیرنو را باعث می‌شود؟

( ) ۱ـ از جا پریدن ( ) ۵ـ باعث بدلرزش در آوردن منزل مسکونی می‌شود

( ) ۲ـ بیدارشدن از خواب ( ) ۶ـ مانع صحبت کردن و گفتگو می‌شود

( ) ۳ـ دخالت در گوش دادن به‌رادیو یاتلویزیون ( ) ۷ـ باعث هیجان و تنش می شود

( ) ۴ـ باعث تکان خوردن و خواب شدن‌تصویر تلویزیون

۱۸. طی یکماه گذشته سروصدای هواپیما کدام موارد را در شما ایجاد کرده‌است ؟

( ) ۱ـ سردرد ( ) ۷ـ حالت خستگی و سستی زیاد

( ) ۲ـ حالت عصبی ( ) ۸ـ حالت افسردگی و فشار روانی

( ) ۳ـ جلوگیری از رفتن به رختخواب (خواب) ( ) ۹ـ باعث اشکال در چشـــــم

( ) ۴ـ بیدار شدن از خواب در طی شب ( ) ۱۰ـ حالت ضعف و گیجی

( ) ۵ـ باعث طپش قلب در شما ( ) ۱۱ـ وادار میکند که شما برای حالت عصبی و یا خوابیدن قرص مصرف کنید

( ) ۶ـ حالت زودرنجی و عصبانیت می شود

۱۹.آیا شما فکر می‌کنید که سروصدا سلامت انسانها را تهدید می‌کند ؟

( ) ۱ـ خیر ( ) ۳ـ بله نسبتا" زیاد

( ) ۲ـ بله خیلی کم ( ) ۴ـ بله خیلی زیاد

۲۰ـ در مجموع چقدر شما از سروصدادر این منطقه ناراحت هستید

( ) ۱ـ ابدا" ناراحت نیستم
( ) ۲ـ کمی ناراحت میشوم
( ) ۳ـ نسبتا" زیاد.
( ) ۴ـ خیلی زیاد

۲۱ـممکن است که بفرمائید شما در مقایسه با مردم نسبت به صدا کمتر حساس هستید یا بیشتر

( ) ۱ـ بیشتر
( ) ۲ـ کمتر
( ) ۳ـ مساوی
( ) ۴ـ نمیدانم

۲۲ـدر طول یکماه گذشته وضع مزاجی و سلامتی شما چگونه بوده‌است .

( ) ۱ـ خیلی خوب .
( ) ۲ـ خوب
( ) ۳ـ متوسط
( ) ۴ـ ضعیف
( ) ۵ـ خیلی بد

۲۳ـ در طول ماه گذشته سروصدای رفت وآمد اتومبیلها چه تاءثیری روی شما داشته است ؟

( ) ۱ـ سردرد
( ) ۲ـ حالت عصبی
( ) ۳ـ اشکال در خوابیدن
( ) ۴ـ بیدار شدن در طول شب
( ) ۵ـ طپش قلب
( ) ۶ـ حالت زودرنجی و عصبانیت
( ) ۷ـ حالت خستگی و ضعف
( ) ۸ـ حالت افسردگی
( ) ۹ـ باعث اشکال در چشم
( ) ۱۰ـحالت ضعف و گیجی
( ) ۱۱ـ وادار میکند شما برای حالت عصبی و یا خوابیدن قرص مصرف کنید

۲۴ـآیا شما در فرودگاه مهرآباد و یا در رابطه با فرودگاه کار میکنید ؟

( ) ۱ـ بله، در فرودگاه
( ) ۲ـ در رابطه با فرودگاه
( ) ۳ـ هیچ کدام

۲۵ـ چه مدت شما در شغل فعلی خود بوده‌اید ؟

( ) ۱ـ کمتر از ۶ ماه
( ) ۲ـ ۶ تا ۱۱ ماه
( ) ۳ـ ۱ تا ۴/۵ سال
( ) ۴ـ ۵ تا ۱۰ سال
( ) ۵ـ بیشتر از ۱۰ سال

۲۶ در هنگام کار کردن چه مقدار شما از سروصدا رنج می برید

( ) ۱ـ ابدا"
( ) ۲ـ کمی
( ) ۳ـ نسبتا"
( ) ۴ـ خیلی زیاد

۲۷ ممکن است بفرمائید مقدار سروصدا در محل کار نسبت به محل سکونت چگونه است ؟

( ) ۱ـ خیلی بیشتر از خانه
( ) ۲ـ کمی بیشتر از خانه
( ) ۳ـ تقریبا" به اندازه آن
( ) ۴ـ مقداری کمتر از خانه
( ) ۵ـ خیلی کمتر از خانه
( ) ۶ـ محل کار در خانه است

۲۸ درطی ماه گذشته کدامیک از ناراحتیها ی زیر را داشته‌اید ؟

( ) ۱ـ گلودرد
( ) ۲ـ تنگی نفس
( ) ۳ـ اسهال
( ) ۴ـ خالت تهوع و استفراغ
( ) ۵ـ سوء هاضمه
( ) ۶ـ ناراحتیهای چشمی
( ) ۷ـ گیجی
( ) ۸ـ سردرد
( ) ۹ـ بی اشتهائی
( ) ۱۰ـ زودرنجی
( ) ۱۱ـ دردسینه
( ) ۱۲ـ کمر درد
( ) ۱۳ـ دردمفاصل ، ساق پا ، ماهیچه‌ها و بازوها
( ) ۱۴ـ طپش قلب
( ) ۱۵ـ زخم کهیر یا سایر ناراحتیهای پوستی
( ) ۱۶ـ خواب وحشتناک
( ) ۱۷ـ ورم پا
( ) ۱۸ـ سوختن بریدن و اتفاقات دیگر
( ) ۱۹ـ حالت خستگی و ضعف
( ) ۲۰ـ احساس صدا در گوش
( ) ۲۱ـ درددوران قاعدگی (در زنان)
( ) ۲۲ـ فشار خون

۲۹کدام موارد را قبل از یکماه اخیر داشته‌اید .

( ) ۱ـ گلو درد
( ) ۲ـ تنگی تنفس
( ) ۳ـ اسهال
( ) ۴ـ حالت تهوع و استفراغ
( ) ۵ـ سرد شانه
( ) ۶ـ ناراحتیهای چشمی
( ) ۷ـ گیجی
( ) ۸ـ سردرد
( ) ۹ـ بی اشتهائی
( ) ۱۰ـ زودرنجی
( ) ۱۱ـ دردسینه
( ) ۱۲ـ کمر درد
( ) ۱۳ـ درد در مفاصل ، ساق پا ، ماهیچه ها و بازوها
( ) ۱۴ـ طپش قلب
( ) ۱۵ـ زخم ـ کهیر یا سایر ناراحتیهای پوستی
( ) ۱۶ـ خواب وحشتناک
( ) ۱۷ـ ورم پا
( ) ۱۸ـ سوختن سبریدن واتفاقات دیگر
( ) ۱۹ـ حالت خستگی و ضعف
( ) ۲۰ـ احساس صدادر گوش
( ) ۲۱ـ درد دوران قاعدگی(در زنان)
( ) ۲۲ـ فشار خون

۳۰آیا شما تاکنون به روان شناس یا روان پزشک یا روان کار مراجعه نموده اید

( ) ۱ـ خیر ( ) ۳ـ بله طی یکماه گذشته
( ) ۲ـ بله قبل از یکماه‌اخیر

۳۱آیا شما هرگز به یک متخصص گوش حلق بینی مراجعه کرده‌اید .

( ) ۱ـ خیر ( ) ۳ـ بله طی یکماه گذشته
( ) ۲ـ بله قبل از یکماه اخیر

۳۲آیا شما مشکلی برای خوابیدن یارفتن به رختخواب دارید

( ) ۱ـ خیر ( ) ۲ـ بله

۳۳اگر بلهٔ دلایل اصلی شما چیست ؟

۳۳آیا در طی شب از خواب بیدار میشوید ؟

( ) ۱ـ خیر ( ) ۲ـ بله

۳۵ اگر بله دلایل اصلی شما چیست ؟

۳۶ شما برای اینکه خواب بروید چکار می کنید ؟

۳۷آیا شما در تابستان موقع خوابیدن پنجره‌ها را باز می گذارید یا بسته ؟

( ) ۱ـ باز ( ) ۲ـ بسته

۳۸ اگر پنجره نگاه می دارید دلایل اصلی شما برای انتخاب چیست ؟

۳۹ شما در قسمت جلوی خانه می خوابید یا عقب ؟

( ) ۱ـ جلو ( ) ۲ـ عقب

۴۵ شما بچه هم دارید ؟

( ) ۱ـ خیر ( ) ۲ـ بله

۴۶ اگر دارید آیا سروصدای آنها تاثیر دارد ؟ آیا آنها را ناراحت میکند ؟

( ) ۱ـ ابدا" ( ) ۲ـ بله نسبتا" زیاد

( ) ۲ـ کمی ( ) ۲ـ بله خیلی زیاد

۴۲ بچه‌های شما از چه صداهایی میترسند ؟

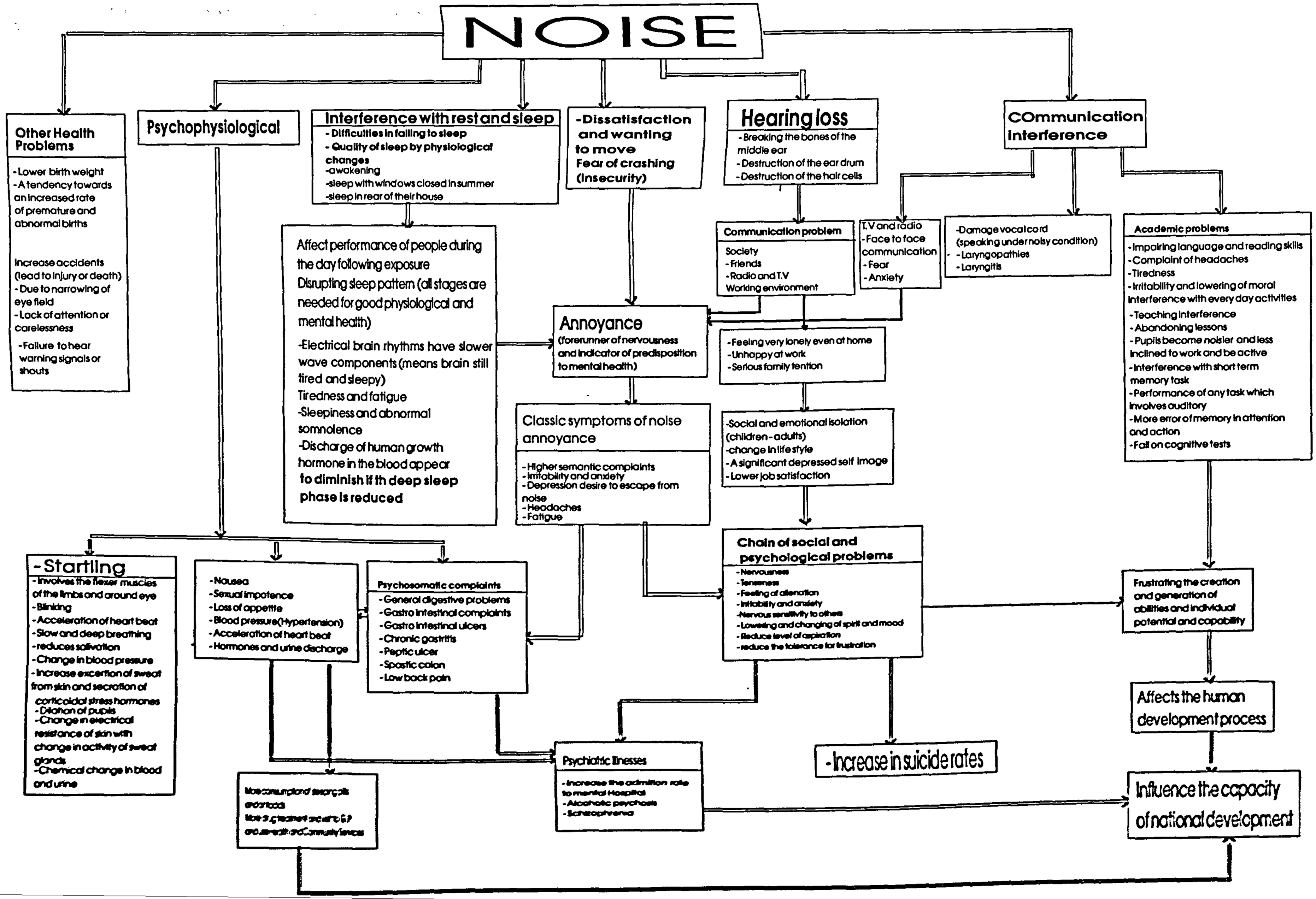
( ) ۱ـ صبح صدایی ( ) ۲ـ قطار

( ) ۲ـ صدای اتومبیل ( ) ۲ـ هواپیما

۴۳آیا بچه‌های شما دچار بی خوابی میشوند .

( ) ۱ـ خیـــر ( ) ۲ـ بله.

۴۴ اگر بله دلایل اصلی آن چیست ؟


NOISE
Other Health Problems
-Lower birth weight
-A tendency towards an increased rate of premature and abnormal births
Increase accidents (lead to injury or death)
-Due to narrowing of eye field
-Lack of attention or carelessness
-Failure to hear warning signals or shouts
Psychophysiological
Interference with rest and sleep
-Difficulties in falling to sleep
-Quality of sleep by physiological changes
-awakening
-sleep with windows closed in summer
-sleep in rear of their house
-Dissatisfaction and wanting to move
Fear of crashing (insecurity)
Hearing loss
-Breaking the bones of the middle ear
-Destruction of the ear drum
-Destruction of the hair cells
COmmunication interference
Affect performance of people during the day following exposure
Disrupting sleep pattern (all stages are needed for good physiological and mental health)
-Electrical brain rhythms have slower wave components (means brain still tired and sleepy)
Tiredness and fatigue
-Sleepiness and abnormal somnolence
-Discharge of human growth hormone in the blood appear to diminish if th deep sleep phase is reduced
Communication problem
Society
-Friends
-Radio and T.V
Working environment
T.V and radio
-Face to face communication
-Fear
-Anxiety
-Damage vocal cord (speaking under noisy condition)
-Laryngopathies
-Laryngitis
Academic problems
-Impairing language and reading skills
-Complaint of headaches
-Tiredness
-Irritability and lowering of moral interference with every day activities
-Teaching interference
-Abandoning lessons
-Pupils become noisier and less inclined to work and be active
-Interference with short term memory task
-Performance of any task which involves auditory
-More error of memory in attention and action
-Fall on cognitive tests
Annoyance
(forerunner of nervousness and indicator of predisposition to mental health)
-Feeling very lonely even at home
-Unhappy at work
-Serious family tention
Classic symptoms of noise annoyance
-Higher semantic complaints
-Irritability and anxiety
-Depression desire to escape from noise
-Headaches
-Fatigue
-Social and emotional isolation (children-adults)
-change in life style
-A significant depressed self image
-Lower job satisfaction
-Startling
-Involves the flexer muscles of the limbs and around eye
-Blinking
-Acceleration of heart beat
-Slow and deep breathing
-reduces salivation
-Change in blood pressure
-Increase excertion of sweat from skin and secration of corticoidal stress hormones
-Dilation of pupils
-Change in electrical resistance of skin with change in activity of sweat glands
-Chemical change in blood and urine
-Nausea
-Sexual impotence
-Loss of appetite
-Blood pressure(Hypertension)
-Acceleration of heart beat
-Hormones and urine discharge
Psychosomatic complaints
-General digestive problems
-Gastro intestinal complaints
-Gastro intestinal ulcers
-Chronic gastritis
-Peptic ulcer
-Spastic colon
-Low back pain
Chain of social and psychological problems
-Nervousness
-Tenseness
-Feeling of alienation
-Irritability and anxiety
-Nervous sensitivity to others
-Lowering and changing of spirit and mood
-Reduce level of aspiration
-reduce the tolerance for frustration
Frustrating the creation and generation of abilities and individual potential and capability
Affects the human development process
Psychiatric illnesses
-Increase the admition rate to mental Hospital
-Alcoholic psychosis
-Schizophrenia
-Increase in suicide rates
Influence the capacity of national development