n-96-01
II-A-689

HEALTH EFFECTS OF NOISE
Literature Survey Update

S. MARTIN TAYLOR
SUSAN E. BIRNIE
FRED L. HALL

McMASTER UNIVERSITY
HAMILTON, ONTARIO
CANADA

HEALTH EFFECTS OF NOISE

Literature Survey Update

S. Martin Taylor
Susan E. Birnie
Fred L. Hall

McMaster University
Hamilton, Ontario
Canada

June 1982

A report submitted to Motor Vehicle Manufacturers Association of the United States, Inc., to fulfill contract number MU 8215-C1102.

Principal Investigators:

MARTIN TAYLOR completed his Ph.D. in Geography at the University of British Columbia in 1974. He is currently an Associate Professor of Geography at McMaster University. He has been actively involved in research on the effects of transportation noise on residential communities for the past seven years.

SUSAN BIRNIE completed her M.Sc. in Urban and Regional Planning at the University of Toronto in 1977. She is currently employed as a Research Associate at McMaster University, where she has worked for the past five years on a number of projects pertaining to transportation noise.

FRED L. HALL holds an M.Sc. in Management from the Sloan School at the Massachusetts Institute of Technology, and completed his Ph.D. in Geography at the University of Chicago in 1972. He is currently an Associate Professor at McMaster University, jointly appointed between the Department of Civil Engineering and the Department of Geography. His research for the past seven years has focussed on community reactions to transportation noise.

Consultant:

WAYNE TAYLOR is a clinical epidemiologist in the department of Clinical Epidemiology and Biostatistics, Faculty of Health Sciences, at McMaster University.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

I INTRODUCTION

In September 1980, the authors submitted a report to the Motor Vehicle Manufacturers Association which reviewed the literature existing at that time concerning the health effects of noise. This report is an update and extension of that literature review, covering material published on that topic since January 1, 1980, and extending the coverage to include infrasound. The time period covered with reference to the effects of infrasound is from 1972 to the present. This report is a brief summary of the findings, based on the same procedures and the same criteria described in full in the 1980 report.

II METHODS

The computerized bibliographic data bases MEDLINE/MEDLARS, BIOSIS, ENGINEERING INDEX, NTIS and INDEX MEDICUS were searched for the period January 1 1980 to March 31 1982 to find those articles related to noise and health. In addition, the same data bases were searched from 1972 to March 31 1982 to find articles related specifically to infrasound. The abstracts for both of these sets of articles were screened to delete those papers which were not relevant to health outcomes. The remaining abstracts were examined in order to choose those papers which are most important to the assessment of the effects of noise on human health. It is these papers which are examined in this report. Fifty nine papers relevant to the effects of noise on health are discussed (Appendix A(i)), and nineteen papers which relate health effects to infrasound (Appendix A(ii)). Those papers examining noise and health or infrasound and health but judged not to be of primary importance for this study are included in Appendices A(iii) and A(iv) respectively.

Each article involving original research was assessed on substantive and methodological grounds, using a form which is very similar to the one used in the previous report (Appendix B). All of the papers were assessed by Mrs. Birnie. Subsets of the papers were also assessed by Dr. Taylor and Dr. Hall. In addition ten papers were independently assessed by Wayne Taylor, a clinical epidemiologist in the Health Sciences faculty at McMaster University. On the papers assessed by all four people, the resulting evaluations were very consistent, confirming the reliability of the primary assessments conducted by Mrs. Birnie. The results of the assessment procedure, including an evaluation of each paper, are provided in the form of a table (Appendix C).

The conclusions drawn concerning the state of the evidence linking health effects to noise are presented separately for noise in general and infrasound.

III RESULTS

1. Effects of noise on health

In the previous report to the MVMA, the authors concluded that the weight of evidence linking noise and health was not strong, and that weak study design was a primary fault in many of the studies. Many of the authors of the 14 review articles examined in this report agree with that conclusion. Kryter (1980) and Stream (1980) both point out that most research designs fail to control for confounding variables adequately, and have further problems with sample size, spurious correlations, and questionable statistics. These problems preclude conclusive results, and open the studies to criticism. Moller (1980) adds that few studies are able to examine the long-term effects of exposure to noise, thereby resulting in practically no evidence concerning the effects on general health. Lambert and Hafner (1979) maintain that many of the effects have not been adequately examined, and that some may be important under certain conditions.

The health effects examined in the 45 papers involving original research cover a range of topics. They involve auditory effects (both hearing loss and temporary threshold shift) and cardiovascular, biochemical, sleep, task performance, and other health effects. The types of noise studied also vary, including industrial, road traffic, aircraft and a number of artificial noise sources.

1.1. Auditory Effects

A total of fifteen articles dealt with auditory effects of noise. Eight studies examined permanent hearing loss, while 7 were concerned with temporary threshold shift. As reported previously, the auditory effect of noise is the only one which is clearly defined and understood. The papers examined here which deal with hearing loss are mainly concerned with industrial noise. The exceptions are (one paper which looks at ambulance paramedics, and one study which is an on-going longitudinal study on children.) They deal most often with hearing loss in a particular industry, although two of the studies are cross-sectional (Alberti et al, 1979 and Schori and Johnson, 1979). Willson et al (1979) are concerned with the relationship of occupational noise-induced hearing loss to general health factors (height, weight, biological parameters), but find no clear relationship.

Generally, these studies add no new information to the existing knowledge concerning noise and hearing loss, or to the guidelines concerning workplace noise. One review article (Lipscomb, 1979) cautions that although such guidelines guard against hearing loss due to occupational noise, they assume that nonoccupational noise levels are sufficiently low to allow the hearing mechanism to recover between exposure periods. The implication of this is that to guard adequately against hearing loss, the community noise level should be less than 70 dBA.

Of the articles concerned with temporary threshold shift, 6 examine the effects of impulse, impact or intermittent noise. Generally they agree that the equal energy assumption and the conventional rules for trade-off between steady state and intermittment noise do not hold, as intermittment noise results in lower threshold shift than the equivalent steady state noise (Yamamura and Aoshima, 1980 and Yamamura and Itoh, 1981), and a number of other variables such as number of impacts, duration and repetition rates are important in the assessment of impact noise (Tremolieres, 1980). Stephenson et al (1980) identify a minimum level of 75-80 dB to produce an asymptotic TTS after 8-16 hours of exposure. On this basis, they conclude that levels less than 75 dB are harmless, even for those exposed for long periods of time.

1.2 Cardiovascular

A total of thirteen papers examined various effects of noise on the cardiovascular system, ranging from ischaemic heart disease and hypertension to blood pressure and peripheral pulse amplitude. Six studies were conducted in the field, while the remainder were laboratory experiments.

Two papers report on well designed studies of industrial noise. Lees and Roberts (1979) conducted a case-control study which found no significant effect of noise on mean blood pressure levels or the incidence of hypertension. Lees et al (1980) examined the incidence of ischaemic heart disease, hypertension and myocardial infarction as well as other health effects such as accidents, absenteeism, alcoholism and mental illness in a prospective cohort study. They found no significant difference between the exposed and control groups, although they were hindered by a small sample size. Knipschild and Sallé (1979) also found no difference between exposed and control groups in the incidence of hypertension and ischaemia, as well as angina pectoris, heart shape pathology, and cardiologist consultations, in a field survey concerned with road traffic noise. These articles provide further support for the conclusion of other reviewers that noise is not a contributing factor to hypertension in industrial settings (Kryter, 1980), that any effects found are not consistent across studies, and that observations are hampered by confounding variables and conflicting results (Harlan et al, 1981).

The remainder of the papers dealing with cardiovascular outcomes were concerned with one or more parameters of a physiological nature rather than a health outcome, often in conjunction with other physiological or biochemical parameters. The implication of studies of this type in the assessment of health state or of pathogenesis of disease is not at all clear, hence they may only be useful for explanations of physiological mechanisms (Jansen, 1978). The parameters studied most often are blood pressure, heart rate and peripheral pulse pressure. Effects for some of the parameters were found in some circumstances, but the evidence is not strong enough or consistent enough to formulate any definite relationship between noise exposure and cardiovascular parameters.

1.3 Biochemical Parameters

Five papers examined biochemical parameters either singly or in combination. One of the articles reported on a field study: Rai et al (1981) examined a number of biochemical parameters in an industrial setting. He found that the levels of cortisol, free cholesterol, and 1 of 5 serum protein levels were significantly higher in the noise group (of 9 parameters studied). In the laboratory experiments, some of the parameters were found to be affected by some noise exposure conditions. However, the criticism applied to the examination of single cardiovascular factors applies here as well. The contribution of such studies to the overall assessment of the effect of noise on health outcomes is extremely limited.

1.4 Sleep

Three papers examine the effect of noise on sleep. One study is a field experiment (Vernet, 1979) which examines sleep disturbance using a number of different parameters, and concludes that for the same L_{eq}, disturbance of sleep due to road noise is greater than that due to rail noise (the number of events for road noise is greater). Sumitsuji et al (1980) found that facial expressions during sleep were related to noise level and sleep stage, and that there was habituation over 3 nights. Levere (1979) emphasizes that total disruption time was most important as an indicator of sleep disturbance. In all three studies, interpersonal differences were very important. We conclude that the assessment of the state of research in this field by Griefahn (1978) is still correct; that the most important conclusion to be drawn from the sleep research is that the significance of sleep disturbance to general health is still unresolved.

1.5 Task performance

A large number of papers looked at the relationship between noise and some measure of task performance. Most of the studies examine the effect of noise on the performance of complex tasks (ones which require a wide range of attention). The mechanism by which noise affects performance of such tasks is postulated to be through a narrowing of the focus of attention, either by an increase in arousal induced by the noise, or by the noise taxing the processing capacity, and hence there is a strategy to decrease the amount of information being processed. The majority of the studies are short-term laboratory experiments involving tasks ranging from counting light flashes to finding embedded figures. The vast majority of the experiments found no effect of noise on task performance. Of those studies which did find an effect, two (Zentall and Shaw, 1980 and Cohen et al, 1980) involved children who were exposed to noise in the classroom. Broadbent (1980), in a review article, claims that although there has been an enormous output of papers on the subject, the issue is still very confusing, due to the examination of performance on main versus peripheral tasks. Cohen (1980) says that noise is just one stress factor, and that unpredictable stress leads to decrements in performance, but that predictability and control over the stress reduce its effect. In general, there is no hard evidence that task performance is affected by noise.

1.6 Other Outcomes

Five papers looked at the effect of noise on other health outcomes. The outcomes examined were anxiety, birth weight, mental health, and general health. In the only lab study, Standing and Stace (1980) conclude that anxiety trait scores increase for noise levels of 75 dB. The remaining studies are all large-scale field surveys dealing with aircraft noise. Knipschild et al (1981) examined birth records and found that the proportion of birth weights less than 3000 grams differred between high and low noise areas. The meaning of this finding is uncertain, however, since the World Health Organization defines prematurity as a birth weight less than 2500 grams (an examination of the data in the article shows that the incidence of prematurity is almost identical between the two areas). Jenkins et al (1981) examined the admissions at three psychiatric hospitals over a four-year period, and found no consistent relationship of admissions with the patient's home noise levels. They conclude that the only effects of noise may be small, weakly influencing other causal factors. The other two articles are a result of the same survey which administered a General Health Questionnaire around London Heathrow Airport. Tarnopolsky et al (1980) examined 27 acute and chronic symptons, and found that the chronic symptoms were more prevalent in the low noise areas, and the acute symptoms were more prevalent in the high noise areas. They concluded that they could find no evidence of noise as a stressor. Watkins et al (1981) examined the use of drugs and medication, the use of psychotropic drugs, visits to a G.P. or out-patient clinic, in-patient status, and use of community health and welfare services. They found no clear results across noise levels for any of the 6 indicators.

1.7 Conclusions

A wide range of effects has been examined in assessing the relationship between noise and health. The articles examined in this review, however, have failed to establish any better than previously a causal link betweeen health outcomes and noise. A number of fairly well designed studies have concluded quite strongly that no relationship can be found.

There are some fairly strong reasons why the articles examined here cannot provide a conclusion to the question being addressed. First, much of the research depends on laboratory experiments, and these are unable to firmly establish a cause and effect relationship between a long term environmental factor and health outcomes. Field studies have the potential to do this, especially through stronger experimental designs such as randomized clinical trials and paired cohort studies. However, the field studies to date have had major problems, especially in the sample design and the control of identified or unidentified intervening or confounding variables.

If we accept the notion the noise is but one of a series of environmental factors (or stressors) that may each affect health in some manner, then establishing the exact effect of noise on health may be an impossible task. Indeed, if noise is but a single factor, and it requires the cumulation of many individual factors to lead to disease, then measuring the incidence of that disease against noise exposure alone will not result in significant results.

2. Effects of infrasound on health

2.1 Introduction

Infrasound is defined as any sound having a frequency less than 20 Hz. This definition was accepted at the International Colloquium on Infrasound in Paris in 1973, and is commonly used in the literature reviewed here. Levels of infrasound between 75 and 95 dB are common from both naturally occurring and man-made sources. Infrasound between 110-120 dB may be produced in motor vehicles (with open windows). Very high levels of infrasound must be artificially produced. Man-made infrasound is normally in the 2-20 Hz region. Infrasound below 2 Hz is usually naturally occurring, and can be caused by jogging, swimming or natural phenomena such as wind and storms (Green and Dunn, 1968).

A common misconception is that infrasound is inaudible. The perception threshold is approximately 90 dB at 20 Hz, and 130-140 dB at 1 Hz (von Gierke and Parker, 1976). Above these levels infrasound is audible. It is not the pure tones that are heard, but rather harmonics generated by distortion from the middle and inner ear.

Infrasound rarely occurs by itself. It is almost always (except for artificial sources) combined with noise of higher frequencies. Therefore, it is extremely difficult to isolate the effects of infrasound. Hence, most of the work investigating the effects is done in a laboratory using an artificial noise source. For this reason there are no studies which directly relate transportation sources to infrasound effects.

Recently attention has been focussed on infrasound because of concerns with space systems, especially during launch. Much of this work involved high levels of infrasound for short periods of time. For example, one of the first objective studies (Mohr et al, 1965) examined whole body exposure at levels up to 154 dB for 2 minutes. For the infrasound exposures, the authors found that 150 dB was well within the human tolerance limits for a variety of effects, including hearing, cardiac rhythm and motor control. Sensations of pressure build-up in the middle ear, and nostril and abdominal vibrations were evident, but disappeared when earmuffs were worn.

Much of the early work which provoked concern about the effects of infrasound was based on personal experience (Gavreau, 1968), or used previous relationships and measurements to make inferences (Bryan and Tempest, 1972) without using statistical methods. Therefore, these studies really provide very little reliable information.

Studies objectively examining the relationship between infrasound and health cover only a small range of effects. The papers examined here examine auditory, physiological, or balance and performance effects.

2.2 Auditory effects

The discussion of auditory effects is limited to temporary threshold shift (TTS). Jerger et al (1966) examined noise in the 2-22 Hz range, at levels of 119-144 dB. Of 19 subjects exposed to the noise for 3 minutes, 8 displayed no TTS effect. The remaining subjects had TTS of 10-22 dB, in the 3-8 KHz range. All of the subjects recovered, and TTS did not accumulate during successive exposures. A higher proportion of hearing impaired subjects reported TTS than did normal hearing subjects.

Von Gierke (in Tempest, 1976, Chapter 6) reports on Johnson's work presented at the International Colloquium in Paris. No TTS was reported for whole body exposures of 120-144 dB for 8 minutes. For ear only exposures of 26 seconds to 30 minutes, at levels of 126-171 dB, some TTS was experienced. One subject had TTS of 8 dB after exposure to 140 dB for 5 minutes, and exposure to 140 dB for 30 minutes resulted in 14-17 TTS. In all cases the subjects recovered full hearing within 30 minutes after exposure.

2.3 Performance

Evans and Tempest (1972) used headsets to deliver infrasound to subjects while measuring nystagmus (involuntary eye movements) as well as reaction time and visual acuity while performing a shape recognition task. The study claims to measure the effects of transportation noise, but in fact the artificially produced tones (130-146 dB at 2-20 Hz) were higher than those actually measured in automobiles. The authors report a significant nystagmus effect, but in a review of this study Harris et al (1976) report that in an examination of the chart provided, after accounting for eye blinks, etc., the slow phase velocity is so small that it would be difficult to classify as nystagmus. Evans and Tempest found no effect on visual disturbance, but a 30% increase in reaction time at low levels (115-120 dB). Since the actual values are not published, it is difficult to verify this. Von Gierke and Parker (1976) contend that Evans and Tempest's findings may be biased since evaluation of the effects was not blind, and that confounders due to audio frequency sound may be possible.

The findings of Evans and Tempest are refuted in other experiments. Johnson (1975) reports on a series of experiments utilizing various frequencies with levels up to 140 dB. No significant effect on rail task performance was found. Von Gierke and Parker (1976) report that experiments have found no effect on visual nystagmus for levels of 142-155 dB.

Cognitive performance was measured using serial search and complex counting tasks (Harris and Johnson, 1978). Fifteen and 30 minute exposures to levels of 125-142 dB resulted in no significant effect. They conclude that very high levels of infrasound may be necessary to produce effects.

Kyriakides and Leventhall (1977) compared the effects of infrasound, audible noise, and alcohol on task performance. They utilized a high priority pointer-following task in conjunction with both central and peripheral components of a secondary task involving response to the onset of light. For a level of 115 dB, there was no significant effect of infrasound on the performance of either the primary or secondary tasks. The authors concluded, however, that changes in performance over time were different for infrasound than for audible noise. A degradation of performance over time was observed for the infrasound condition, while performance was maintained over time for the audible noise condition. Therefore, a significant change in performance may be apparent if the time of exposure is increased.

2.4 Physiology

Since the middle ear is the most susceptible part of the body to infrasound, it has been suggested that the physiological tolerance limit to infrasound is determined by the middle ear (Johnson, 1975). The pain threshold for the middle ear is 140 dB at 20 Hz, and 162 dB at 2 Hz (von Gierke and Parker, 1976). Slarve and Johnson (1975) examined human whole body exposure to a maximum of 144 dB for 8 minutes. They found no effects on auditory acuity, respiration rate, pulse rate and the general condition of the eardrum. The effects found were middle ear pressure build-up (above 126 dB), voice modulation (above 135 dB) and chest vibration (above 135 dB). Johnson (1975) reports on an experiment by Borredon which provided exposure for 50 minutes at 130 dB. The only effect found was a small (< 1.5 mm Hg) increase in the minimum arterial blood pressure. In addition, several of the subjects reported a drowsy feeling.

2.5 Conclusion

Those papers which have reviewed the full range of literature on the effects of infrasound (Johnson, 1975, Harris et al, 1976, von Gierke and Parker, 1976, Johnson, 1976, Johnson, 1980) conclude that the early reports of drastic effects of infrasound were greatly exaggerated. The current concensus about the effects of infrasound is as follows:

1. whole body effects - no subjective effects until greater than 150 dB
   - middle ear pressure build-up at 130 dB.
2. vestibular - no effect up to 155 dB.
3. respiratory - rhythm change about 130 dB
   - definite effect at 166 dB.
4. performance - limit not reached
   - only speech interference below 142 dB.
5. auditory - some TTS for exposures greater than 20 minutes.
   - 150 dB acceptable if exposure less than 30 minutes.

Infrasound must be regarded as only a very small part of the problem of the health effects of noise. At levels commonly found in motor vehicles, there is no firm indication that any harmful effects due to infrasound may occur.

Appendix A(i)

Bibliography of Material Examined - Noise

Alberti, P.W., Symons, F., Hyde, M.L. (1979).
Occupational hearing loss. The significance of asymmetrical hearing thresholds.
Acta Otolaryngol 87, pp. 255-263.

Ambasankaran, M., Brahmachari, D., Chadda, V.K., Phadnis, M.G., Raju, A., Ramamurthy, A., Shah, V.R. (1981).
Occupational noise exposure and hearing levels.
Am Ind Hyg Assoc J 42(7), pp. 551-555.

Andren, L., Hansson, L., Björkman, M., Jonsson, A. (1980).
Noise as a contributing factor in the development of elevated arterial pressure. A study of the mechanisms of which noise may raise blood pressure in man.
Acta Med Scand 207(6), pp. 493-498.

Arnoult, M.D., Voorhees, J.W. (1980).
Effects of aircraft noise on an intelligibility task.
Human Factors 22(2), pp. 183-188.

Battig, K., Zeier, H., Muller, R., Buzzi, R. (1980).
A field study on vegetative effects of aircraft noise.
Arch Environ Health 35(4), pp. 228-235.

Broadbent, D.E. (1980).
Noise in relation to annoyance, performance, and mental health.
J Acoust Soc Am 68(1), pp. 15-17.

Cohen, S. (1980).
Aftereffects of stress on human performance and social behaviour: a review of research and theory.
Psychol Bull 88(1), pp. 82-108.

Cohen, S., Evans, G.W., Krantz, D.S., Stokols, D. (1980).
Physiological, motivational, and cognitive effects of aircraft noise on children: moving from the laboratory to the field.
Am Psychol 35(3), pp. 231-243.

Committee on Hearing, Bioacoustics and Biomechanics (1981).
The effects on human health from long-term exposures to noise.
National Research Council, Washington, D.C.

Follenius, M., Brandenberger, G., Lecornu, C., Simeoni, M., Reinhardt, B. (1980).
Plasma catecholamines and pituitary adrenal hormones in response to noise exposure.
Eur J Applied Physiol 43(3), pp. 253-261.

Fruhstorfer, B., Hensel, H. (1980).
Extra-auditory responses to long-term intermittent noise stimulation in humans.
J Appl Physiol 49(6), pp. 985-993.

Griefahn, B. (1978).
Research on noise-induced sleep since 1973.
in Proceedings of the Third International Congress on Noise as a Public Health Problem, Frieburg, West Germany, pp. 377-390.

Harlan, W.R., Sharrett, A.R., Weill, H., Turino, G.M., Borhani, N.O., Resnekov, L. (1981).
Impact of environment on cardiovascular disease. Report of the American Heart Association task force on cardiovascular disease.
Circulation 63(1), pp. 242A-271A.

Harris, C.S., Shoenberger, R.W. (1980).
Combined effects of broadband noise and complex waveform vibration on cognitive performance.
Aviat Space Environ Med 51(1), pp. 1-5.

Ising, H., Dienel, D., Günther, T., Markert, B. (1980).
Health effects of traffic noise.
Int Arch Occup Environ Health 47(2), pp. 179-190.

Jansen, G. (1978).
Research on extra aural noise effects since 1973.
in Proceedings of the Third International Congress on Noise as a Public Health Problems, Frieburg, West Germany, pp. 221-236.

Jenkins, L., Tarnopolsky, A., Hand, D. (1981).
Psychiatric admissions and aircraft noise from London Airport: four-year, three-hospitals' study.
Psychol Med 11(4), pp. 765-782.

Johnson, D.L. (1980).
Quantifiable effects of noise on humans.
Aerospace Medical Research Lab, Wright-Patterson AFB, Ohio.

Johnson, D.W., Hammond, R.J., Sherman, R.E. (1980).
Hearing in an ambulance paramedic population.
Ann Emerg Med 9(11), pp. 557-561.

Johnson, L.C. (1979).
Sleep disturbance in humans.
in AGARD Lecture Series, Sleep, wakefulness and circadian rhythm N105, pp. 4-1 to 4-16.

Jones, D., Broadbent, D. (1979).
Side-effects of interference with speech by noise.
Ergonomics 22(9), pp. 1073-1081.

Knipschild, P., Meijer, H., Sallé, H. (1981).
Aircraft noise and birth weight.
Int Arch Occup Environ Health 48(2), pp. 131-136.

Knipschild, P., Sallé, H. (1979).
Road traffic noise and cardiovascular disease. A population study in the Netherlands.
Int Arch Occup Environ Health 44(1), pp. 55-60.

Kryter, K.D. (1980).
Physiological acoustics and health.
J Acoust Soc Am 68(1), pp. 10-14.

Kryter, K.D., Poza, F. (1980).
Autonomic system activity and performance on a psychomotor task in noise.
J Acoust Soc Am 67(6), pp. 2096-2101.

Kryter, K.D., Poza, F. (1980).
Effects of noise on some autonomic system activities.
J Acoust Soc Am 67(6), pp. 2036-2044.

Lambert, D.R., Hafner, F.S. (1979).
Behavioral and physiological effects of noise on people.
Naval Ocean Systems Center, San Diego, Ca.

Lees, R., Roberts, H. (1979).
Noise-induced hearing loss and blood pressure.
Can Med J 120, pp. 1082-1084.

Lees, R.E., Romeril, C.S., Wetherall, L.D. (1980).
A study of stress indicators in workers exposed to industrial noise.
Can J Public Health 71(4), pp. 261-265.

Levere, T.E. (1979).
Arousal from sleep: the uniqueness of an individuals' response and the problem of noise control.
Neuropsychology Lab, North Carolina State Univ., Raleigh.

Lipscomb, D.M. (1979).
Considerations of community noise impact on hearing health.
Community Noise, ASTM STP 692, R.J. Peppin and C.W. Rodman, Eds., American Society for Testing and Materials, 1979, pp. 73-79.

Lovallo, W.R., Pishkin, V. (1980).
Performance of type A (coronary-prone) men during and after exposure to uncontrollable noise and task failure.
J Pers Soc Psychol 38(6), pp. 963-971.

Moller, A.R. (1980).
Effects of the physical environment. Noise as a health hazard.
in Maxcy-Rosenau, J.M. Public Health and Preventive Medicine, 11th edition. New York: Appleton-Century-Crofts, pp. 790-799.

Moller, L.E. (1980).
Performance of musicians under noise.
Percept Mot Skills 50(1), pp. 301-302.

Oleru, U.G. (1980).
Comparison of the hearing levels of Nigerian textile workers and a control group.
Am Ind Hyg Assoc J 41(4), pp. 283-287.

Percival, L., Loeb, M. (1980).
Influence of noise characteristics on behavioural after effects.
Hum Factors 22(3), pp. 341-352.

Pfander, F., Bongartz, H., Brinkmann, H., Kietz, H. (1980).
Danger of auditory impairment from impulse noise: A comparative study of the CHABA damage-risk criteria and those of the Federal Republic of Germany.
J Acoust Soc Am 67(2), pp. 628-633.

Rai, R.M., Singh, A.P., Upadhyay, T.N., Patil, S.K., Nayar, H.S. (1981).
Biochemical effects of chronic exposure to noise in man.
Int Arch Occup Environ Health 48(4), pp. 331-337.

Roche, A.F., Himes, J.H., Siervogel, R.M., Johnson, D.L. (1979).
Longitudinal study of human hearing: its relationship to noise and other factors. II. Results from the first three years.
Fels Research Inst., Yellow Springs, Oh.; Aerospace Medical Research Lab., Wright-Patterson, AFB, Oh.

Roevekamp, A.J.M. Passchier-Vermeer, W. (1978).
Noise effects. Effects of noise exposure on blood circulation and respiration of man. Part 1: Results of a two-hour noise exposure on groups of younger and older people.
Research Institute for Environmental Hygiene, TNO, Delft.

Schori, T.R., Johnson, D.L. (1978).
Inter-industry noise study: another look.
Sound and Vibration 13(1), pp. 16-21.

Smith, A.P., Broadbent, D.E. (1980).
Effects of noise on performance on embedded figures tasks.
J Appl Psychol 65(2), pp. 246-248.

Standing, L., Stace, G. (1980).
The effects of environmental noise on anxiety level.
J Gen Psychol 103(Second Half), pp. 263-272.

Stephenson, M.R., Nixon, C.W., Johnson, D.L. (1980).
Identification of the minimum noise level capable of producing an asymptotic temporary threshold shift.
Aviat Space Environ Med 51(4), pp. 391-396.

Stream, R.W. (1980).
Effects of industrial and community noise on health.
in Trieff, N.M. (ed) Environment and Health, Ann Arbor Science Publishers, Inc., Ann Arbor, Mich., pp. 331-366.

Sulkowski, W.J. (1980).
Hearing impairment caused by impulse noise: survey in the drop forging industry.
Scand Audiol [Suppl] Suppl 12, pp. 307-317.

Sumitsuji, N., Nanno, H., Kuwata, Y., Ohta, Y. (1980).
The effects of the noise due to the jet airplane to the human facial expression (EMG study), EEG change and their manual responses to various sleeping stages of the subjects.
Electromyogr Clin Neurophysiol 20(1), pp. 49-72.

Tarnopolsky, A., Watkins, G., Hand, D.J. (1980).
Aircraft noise and mental health: I. Prevalence of individual symptoms.
Psychol Med 10(4), pp. 683-698.

Thackray, R.I., Touchstone, R.M. (1979).
Effects of noise exposure on performance of a simulated radar task.
Office of Aviation Medicine, Federal Aviation Administration, Washington, D.C.

Thompson, S.J. (1981).
Epidemiology feasibility study: effects of noise on the cardiovascular system.
Department of Epidemiology and Biostatistics, University of South Carolina, Columbia, S.C.

Trémolières, C., Hétu, R. (1980).
A multi-parametric study of impact noise-induced TTS.
J Acoust Soc Am 68(6), pp. 1652-1659.

Vernet, M. (1979).
Effect of train on sleep for people living in houses bordering the railway line.
J Sound Vib 66(3), pp. 483-492.

Watkins, G., Tarnopolsky, A., Jenkins, L.M. (1981).
Aircraft noise and mental health: II. Use of medicines and health care services.
Psychol Med 11(1), pp. 155-168.

Willson, G.N., Chung, D.Y., Gannon, R.P., Roberts, M., Mason, K. (1979).
Is a healthier person less susceptible to noise induced hearing loss?
J Occup Med 21(9), pp. 627-630.

Yamamura, K., Aoshima, K. (1980).
An investigation of biological response induced by intermittent noise (trapezoidal noise).
Eur J Applied Physiol 44(1), pp. 9-16.

Yamamura, K., Aoshima, K., Hiramatsu, S., Hikichi, T., Hiramatsu, S., (1980).
An investigaton of the effects of impulse noise on man: impulse noise with a relatively low peak level.
Eur J Applied Physiol 43(2), pp. 135-142.

Yamamura, K., Itoh, F. (1981).
The effects of variable noise level on man with peak levels below 75 dB(A).
Eur J Applied Physiol 46(1), pp. 69-76.

Yamamura, K., Itoh, F., Maehara, N. (1981).
Physiological responses induced by 555-min exposure to intermittent noise.
Eur J Applied Physiol 47(3), pp. 257-269.

Zentall, S.S., Shaw, J.H. (1980).
Effects of classroom noise on performance and activity of second-grade hyperactive and control children.
J Educ Psychol 72(6), pp. 830-840.

Appendix A(ii)

Bibliography of Material Examined - Infrasound

Andreeva-Galanina, E.Ts., Malyshev, E.N. Pronin, A.P., Skorodumov, G.E. (1980).
Effect of infrasound on the human organism.
Gig Sanit 35(11), pp. 65-69.

Brown, R. (1973).
What levels of infrasound are safe?
New Scientist 8, pp. 414-415.

Bryan, M., Tempest, W. (1972).
Does infrasound make drivers drunk?
New Scientist 53(787), pp. 584-586.

Evans, M.J., Tempest, W. (1972).
Some effects of infrasonic noise in transportation.
J Sound Vib 22(1), pp. 19-24.

Gavreau, V. (1968).
Infrasound.
Sci J 4, pp. 33-37.

Gierke, H.E. von, Parker, D.E. (1976).
Infrasound.
in Handbook of sensory physiology (West Germany) 5(3), pp. 585-624.

Green, J.E., Dunn, F. (1968).
Correlation of naturally occurring infrasonics and selected human behaviour.
J Acoust Soc Am 44(5), pp. 1456-1457.

Harris, C.S., Johnson, D.L. (1978).
Effects of infrasound on cognitive performance.
Aviat Space Environ Med 49(4), pp. 582-586.

Harris, C.S., Sommer, H.C., Johnson, D.L. (1976).
Review of the effects of infrasound on man.
Aviat Space Environ Med 47(4), pp. 430-434.

Jerger, J., Alford, B., Coats, A. (1966).
Effects of very low frequency tones on auditory thresholds.
J Speech Hear Res 9(1), pp. 150-160.

Johnson, D.L. (1975).
Auditory and physiological effects of infrasound.
in Proceedings of Inter-Noise 75, International Conference on Noise Control Engineering, Sendai, Japan.

Johnson, D.L. (1976).
Infrasound, its sources and its effects on man.
presented at Electro 76, Boston, Mass. Institute of Electrical and Electronics Engineers, Inc.

Johnson, D.L. (1980).
The effects of high level infrasound.
Aerospace Medical Research Lab, Wright-Patterson AFB, Ohio.

Kyriakides, K., Leventhall, H.G. (1977).
Some effects of infrasound on task performance.
J Sound Vib 50(3), pp. 369-388.

Mohr, G.C., Cole, J.N., Guild, E., Gierke, H.E. Von (1965).
Effects of low frequency and infrasonic noise on man.
Aerospace Med 36(9), pp. 817-824.

Nixon, C.W., Johnson, D.L. (1973).
Infrasound and hearing.
in Proceedings of the International Congress on Noise as a Public Health Problem, Dubrovnik, Yugoslavia, pp. 329-347.

Slarve, R.N., Johnson, D.L. (1975).
Human whole-body exposure to infrasound.
Aviat Space Environ Med 46(4), pp. 428-431.

Tempest, W. (ed.) (1976).
Infrasound and low frequency vibration.
London: Academic Press.

Westin, J.B. (1975).
Infrasound: a short review of effects on man.
Aviat Space Environ Med 46(9), pp. 1135-1140.

Appendix A(iii)

Bibliography of Other Relevant Material - Noise

Note: Titles in square brackets [ ] indicate a translation of the title of a non-English article.

Akbulut, T., Cokan, Y. (1980).
[Psychological effects of industrial noise.]
Istanbul Universitesi Tip Fukultesi Mecmuasi 43(2), pp. 359-365.

Alberti, P.W., Hyde, M.L., Symons, F.M., Miller, R.B. (1980).
The effect of prolonged exposure to industrial noise on ostosclerosis.
Laryngoscope 90(3), pp. 407-413.

Andren, L., Lindstedt, G., Björkman, M., Borg, K.O., Hansson, L. (1982).
Effect of noise on blood pressure and "stress" hormones.
Clin Sci 62(2), pp. 137-141.

Anonymous (1980).
Noise in the textile industry (conference).
CSIRO division of Test Industry, Belmont, Victoria, Australia.

Anttonen, H., Hassi, J., Riihikangas, P., Sorri, M. (1980).
Impulse noise exposure during military service.
Scand Audiol [Suppl] Suppl 12, pp. 17-24.

Artiukhina, N.I., Gekht, K.K., Levshina, I.P., Kuvaeva, O.F. (1981).
[Neurono-glial changes in the cerebral cortex of animals exposed to white noise.]
Arkh Anat Gistol Embrid 81(9), pp. 27-33.

Artiukhina, N.I., Kuvaeva, O.F., Levshina, I.P. (1981).
[Effect of white noise on the rat auditory cortex ultrastructure.]
Biull Eksp Biol Med 91(4), pp. 495-498.

Axelsson, A., Jerson, T., Lindgren, F. (1981).
Noisy leisure time activities in teenage boys.
Am Ind Hyg Assoc J 42(3), pp. 229-233.

Axelsson, A., Vertes, D., Miller, J. (1981).
Immediate noise effects on cochlear vasculature in the guinea pig.
Acta Otolaryngol (Stockh) 91(3-4), pp. 237-246.

Bender, D.R., Mueller, H.G. (1981).
Military noise induced hearing loss: incidence and management.
Milit Med 146(6), pp. 434-437.

Borg, E. (1981).
Noise, hearing and hypertension [editorial].
Scand Audiol 10(2), pp. 125-126.

Borg, E. (1980).
Processing of intensity-correlated information in an acoustic-autonomic reflex system.
Brain Res 188(1), pp. 43-51.
Borsky, P.N. (1979).
Socio-psychological factors affecting the human response to noise exposure.
Otolarynogol Clin North Am 12(3), pp. 521-536.

Bourgeouis, P., Dupont, W., Busnel, M.C. Molin, D. (1979).
[Hormonal retention of acoustic stress during gestation and the 1st days of life in deaf and hearing young mice according to the noise conditions existing during raising of the young and surrounding the mother.]
Physiologie 75(5), p. 26A.

Bovt, I.G. (1978).
[Clinical and audiological characteristics of occupational hypoacusis caused by the effect of noise of great intensity.]
Vestnik Otorinol 0(5), p. 110.

Bowman, D.C., Blanchet, L.J., Doemling, D.B. (1980).
Temporary auditory threshold shift following sophomore operative technique laboratory.
J Dent Educ 44(5), pp. 261-263.

Brandenberger, G., Follenius, M., Wittersheim, G., Salame, P. (1980).
Plasma catecholamines and pituitary adrenal hormones related to mental task demand under quiet and noise conditions.
Biol Physchol 10(4), pp. 239-252.

Briese, V., Gasow, H., Fanghänel, J., Morning, M. (1981).
[Animal experiments to study effects of pure sound and street noise on ontogenesis of mouse.]
Zentrabl Gynakol 103(18), pp. 1113-1117.

Britanov, N.G. (1979).
[Effect of noise and acetone on female workers of acetate and polyvinyl chloride fiber factories.]
Gig Tr Prof Zabol 12, pp. 15-19.

Buck, K., Lombardo, D., Devigne, C. (1980).
Effects of continuous and impulse noise.
Scand Audiol [Suppl] Suppl 12, pp. 116-120.

Canlon, B., Schacht, J. (1981).
The effect of noise on deoxyglucose uptake into inner ear tissues of the mouse.
Arch Otorhinolaryngol 230(2), pp. 171-176.

Cattin, L., Da Col, P.G., Zotti, E., Calabrese, S., de Zotti, R., Volpe, C., Fiorito, A., Biava, P.M. (1980).
[Cardiovascular risk factors in a population of shipyard workers.]
Giornale Dell'arteriosclerosi 4(2), pp. 115-126.

Chen, C.S., Aberdeen, G.C. (1980).
Potentiation of noise-induced audiogenic seizure risk by salicylate in mice as a function of salicylate-noise exposure interval.
Acta Otolarynogol (Stockh) 90(1-2), pp. 61-65.

Chung, D.Y., Gannon, R.P. (1980).
Hearing loss due to noise trauma.
J Laryngol Otol 94(4), pp. 419-423.

Ciesielski, S., Kopka, J., Kidawa, B. (1980).
Incubator noise and vibration - possible iatrogenic influence on neonate.
Int J Pediatr Otorhinolaryngol 1(4), pp. 309-316.

Cody, A.R., Johnstone, B.M. (1980).
Electrophysiological and morphological correlates in the guinea pig cochlea after exposure to impulsive noise.
Scand Audiol [Suppl] Suppl 12, pp. 121-127.

Cody, A.R., Johnstone, B.M. (1980).
Single auditory neuron response during acute acoustic trauma.
Hear Res 3(1), pp. 3-16.

Cohen, A., Taylor, W., Tubbs, R. (1980).
Occupational exposures to noise, hearing loss, and blood pressure.
ASHA Reports 23(10), pp. 322-326.

Cohen, I. (1979).
Stress and wound healing.
Acta Anatomica 103(2), pp. 134-141.

Cohen, S., Krantz, D.S., Evans, G.W., Stokols, D. (1981).
Cardiovascular and behavioural effects of community noise.
Am Sci 69(5), pp. 528-535.

Colurso, G.J., Anthony, A. (1978).
Circulating cortico sterone levels in dexamethasone treated rats subjected to noise stress.
Proc Penn Acad Sci 52(1), pp. 107-108.

Cornaby, B.W., Savitz, D.A., Pomerantz, L., Murthy, K.S. (1978).
Development of environmental objectives based on health and ecological effects.
in Proceedings of International Conference on Fluid Bed Combustion 5th. V 2, Near-term Implementation. Washington, D.C. 1977.

Defares, P.B. (1979).
Social perception and environmental quality.
Urban Ecol 4(2), pp. 119-138.

De Jong, R.G. (1978).
[Investigating the noise pollution problem. A theoretical model.]
Research Institute in Environmental Hygiene, TNO, Delft, Netherlands.

Dempsey, T.K. (1980).
Variation of aircraft noise annoyance.
presented at the 99th Acoustical Society of America Meeting, Atlanta, 1980.

Dixon, J.P. (1978).
Single unit recordings of cells responsive to visual, somatic, acoustic, and noxious stimuli in the superior colliculus of the golden hamster.
Thesis. Air Force Institute of Technology. Wright-Patterson AFB, Ohio.

Dobie, R.A. (1980).
Asymmetrical hearing loss [letter].
West J Med 133(5), pp. 448-449.

Ehrenstein, W., Weber, F. (1978).
The effect of heavy noise presented during 8 consecutive days on sleep stage patterns, mood, and autonomic functions.
in L., Popoviciu, B., Asgian, G. Badiu, (ed). European Congress on Sleep Research, No. 4.

El Alami, A.M. (1981).
Study on hearing ability and its relationship to noise levels in an East London factory.
J Soc Occup Med 31(1), pp. 27-30.

Erickson, D.A, Fausti, S.A., Frey, R.H. Rappaport, B.Z. (1980).
Effects of steady-state noise upon human hearing sensitivity from 8000 to 20,000 Hz.
Ann Ind Hyg Assoc J 41(6), pp. 427-432.

Erlandsson, B., Håkanson, H., Ivarsson, A., Nilsson, P., Wersäll, J. (1980).
Hair cell damage in the guinea pig due to different kinds of noise.
Acta Otolaryngol [Suppl] (Stockh) Suppl 367, pp. 1-43.

Fanghaenel, J., Schumacher, G-H., Dahl, D. (1979).
[Teratologic model study on the effect of noise and vibrations on fetal development.]
Zentralblatt fuer Allgemeine Pathologie und Pathologische Anatomie 123(1-2), p. 118.

Fausti, S.A., Erickson, D.A., Frey, R.H., Rappaport, B.Z. (1981).
The effects of impulsive noise upon human hearing sensitivity (8 to 20 kHz).
Scand Audiol 10(1), pp. 21-29.

Fausti, S.A., Erickson, D.A., Frey, R.H., Rappaport, B.Z., Schechter, M.A. (1981).
The effects of noise on human hearing sensitivity from 8000 to 20,000 Hz.
J Acoust Soc Am 69(5), pp. 1343-1347.

Ferraro, J.A., Melnick, W., Gerhardt, K.R. (1981).
Effects of prolonged noise exposure in chinchillas with severed middle ear muscles.
Am J Otolaryngol 2(1), pp. 13-18.

Fialkowska, D., Janczewski, G., Kochanek, K., Dawidowicz, J. (1980).
Audiological findings in the impulse - noise induced hearing loss. Electrocochleographic (ECoG) studies. A preliminary report.
Scand Audiol [Suppl] Suppl 12, pp. 257-264.

Fisch, L. (1981).
Aircraft noise and hearing impairment in children.
Br J Audiol 15(4), pp. 231-240.

Follenius, M., Brandenberger, G. (1979).
Changes in plasma levels of catecholamines ACTH growth hormone and cortisol in man at rest subjected or not subjected to noise stress.
Physiologie 75(5), pp. 28A.

Francois, J. (1981).
The annoyance caused by airplane noise in the vicinity of Orly Airport and the reaction of neighbouring residents.
Translation of "La gene causee par le bruit des avions au voisinage de l'Aeroport d'Orly et les reactions de riverains." Institute Francais d'Opinion Publique, Paris, 1972.

Freidinger, M., Laharotte, J. (1981).
[Destruction of cochlear cells observed in guinea pigs after exposure to pink noise at 95-97.5 and 100 decibels dB(A).]
Agressologie 22(1), pp. 29-34

Garcia, B.N. (1979).
Effects of agricultural and industrial pollution on public health.
SE Asian J Trop Med Pub Health 10(4), pp. 600-603.

Gaskell, H., Henning, G.B. (1981).
The effect of noise on time-intensity trading in lateralization.
Hear Res 4(2), pp. 161-174.

Geltishcheva, E.A. (1980).
[Dynamics of the state of the cardiovasular system in adolescents performing precise visual operations during exposure to occupational noise.]
Gig Tr Prof Zabol 1, pp. 25-29.

Gerhardt, K.J., Melnick, W., Ferraro, J.A. (1980).
Acoustic reflex decay in chinchillas during a long-term exposure to noise.
Ear Hear 1(1), pp. 33-37.

Gerykova, M. (1979).
Occupational hearing hazard from impulsive noise.
Scripta Medica Facultatis Medicae Universitatis Brunensis Purkymianae 52(7), pp. 439-448.

Gill, H.S. (1980).
Assessment, prediction and control of noise exposure of construction plant operators.
Institute of Sound and Vibration Research, Southampton University, England.

Gloag, D. (1980).
Noise and health: public and private responsibility.
Br Med J 281(6252), pp. 1404-1406.

Gloag, D. (1980).
Noise: hearing loss and psychological effects.
Br Med J 281(6251), pp. 1325-1327.

Gonzalez, E.R. (1980).
No proof of environmental ill effects on heart [news].
JAMA 243(12), pp. 1219-1220.

Graf, R., Mueller, R., Meier, H.P. (1980).
Socio-psychological airplane noise investigation in the districts of three Swiss airports: Zurich, Geneva and Basel.
Translation of "Sozio-psychologische flughaefen Zuerich, Genf, Basel". Bern, Switzerland 1974.

Gunn, W.J. (1979).
A proposed theoretical framework for a comprehensive research program on human response to aircraft noise.
J Aud Res 18(2), pp. 99-114.

Guray, O., Sabuncu, H. (1979).
[The noise problem in view of environmental health at Istanbul Turkey.]
Istanbul Universitesi Tip Fakultesi Mecmuasi 41(4), pp. 571-578.

Hamernik, R.P., Henderson, D., Coling, D., Salvi, R. (1981).
Influence of vibration on asymptotic threshold shift produced by impulse noise.
Audiology 20(3), pp. 259-269.

Hamernik, R.P., Henderson, D., Coling, D., Slepecky, N. (1980).
The interaction of whole body vibration and impulse noise.
J Acoust Soc Am 67(3), pp. 928-934.

Hamernik, R.P., Henderson, D., Salvi, R.J. (1980).
Contribution of animal studies to our understanding of impulse noise induced hearing loss.
Scand Audiol [Suppl] (Suppl 12), pp. 128-146.

Hartoon, J.C., Treuting, E.G. (1981).
Is noise a potential hazard to pregnancy?
Occup Health Nurs 29(1), pp. 20-23.

Hayne, C. (1981).
The body's reaction to noise.
Occup Health (London) 33(2), pp. 75-83.

Hodge, D.C., Price, G.R., Dukes, N.L., Murff, S.J. (1979).
Effects of artillery noise on the hearing of protected crew personnel.
Human Engineering Lab, Aberdeen Proving Ground, Md.

Honma, H.
Studies on the activity level of the cerebral cortex by noise exposure with regard to the function of maintaining concentration and average auditory evoked response.
Hokkaido J Med Sci 56(1), pp. 55-66.

Ising, H. (1981).
Interaction of noise-induced stress and Mg decrease.
Artery 9(3), pp. 205-211.

Ising, H., Merker, H.J., Guenther, T., Gelderblom, H. Oezel, M. (1979).
Increase of collagen in the rat heart induced by noise.
Environ Int 2(2), pp. 95-105.

Ivanenko, G.A. (1981).
[Response of spinal cord capillaries of white rats to exposure to noise.]
Arkh Anat Gistol Embriol 81(7), pp. 54-58.

Jahrsdoerfer, R. (1979).
The clinical evaluation of noise induced hearing loss.
Otolaryngol Clin North Am 12(3), pp. 637-638.

Jansen, G. (1981).
[The effect of noise.]
Zenbralbl Arbeitsmed Arbeitsschutz Prophyl Ergonomie 31(6), pp. 220-224.

Januszewicz, W., Sznajderman, M., Wocial, B., Feltynowski, T., Klonowicz, T. (1979).
The effect of mental stress on catecholamines, their metabolites and plasma renin activity in patients with essential hypertension and healthy subjects.
Clinical Science 57(Suppl 5), pp. 229S-232S.

Jasinski, C. (1980).
Noise induced hearing loss in aviators.
Hawaii Med J 39(12), pp. 307-309.

Joss (1980).
The annoyance caused by noise around airports.
translation of "La gene causee par la bruit autour des aeroports," Centre Sci. et Tech. du Batiment, Paris, 1968.

Kamata, S. (1980).
[Disposition of noise induced hearing loss with special reference to consanquinity].
Hirosaki Igaku 32(3), pp. 336-368.

Kamenskii, Yu.N. (1980).
[Psycho-physiological changes in flight personnel of civilian helicopters in relation to the extent of their duties.]
Kosmicheskaya Biologiya I Aviakosmicheskaya Meditsina 14(2), pp. 86-89.

Kamenskii, Yu.N., Sokolova, E.A. (1979).
[Age related changes of psycho-physiological functions of civil pilots due to the vibration noise effects.]
Kosmicheskaya Biologiya I Aviakosmicheskaya Meditsina 13(5), pp. 21-24.

Karam, F. (1980).
Acoustic trauma in unprotected airport workers.
J Med Liban 31(3), pp. 281-285.

Karvonen, M.J. (1979).
Ergonomic criteria for occupational and public health surveys.
Ergonomics 22(6), pp. 641-650.

Kay, K.F., Payne, M.C. Jr. (1981).
Effects of noise frequency on performance and annoyance for women and men.
Percept Mot Skills 51(2), pp. 435-441.

Kluczek, J.F. (1979).
Hematological changes in human subjects exposed to excessive noise caused by animals.
Acta Physiol Pol 30(1), p. 100.

Knauth, P., Rutenfranz, J., Schulz, H., Bruder, S., Romberg, H.P., Decoster, F., Kiesswetter, E. (1980).
Experimental shift work studies of permanent night and rapidly rotating shift systems. 2. Behaviour of various characteristics of sleep.
Int Arch Occup Environ Health 46(2), pp. 111-126.

Krista, L.M., Beckett, S.D., Branch, O.E., McDaniel, G.R., Patterson, R.M. (1981).
Cardiovascular responses in turkeys as affected by duirnal variation and stressors.
Poultry Science 60(2), pp. 462-468.

Ladou, J. (1980).
Asymmetrical hearing loss.
West J Med 133(2), p. 151.

Lambert, D.R. (1980).
Requirements for sleep, solving problems, and speech communications in shipboard compartments. A survey of U.S. Navy Personnel opinions.
Naval Ocean Systems, Center, San Diego, Ca.

Leatherwood, J.D., Dempsey, T.K., Cleveson, S.A. (1980).
Design tool for estimating passenger ride discomfort within complex ride environments.
Hum Factors 22(3), pp. 291-312.

Legouix, J.P., Pierson, A. (1980).
Role of the acoustical pressure polarity in the cochlear fatigue provoked by impulse noise.
Scand Audiol [Suppl] Suppl 12, pp. 147-153.

Lenoir, M., Pujol, R. (1980).
Sensitive period to acoustic trauma in the rat pup cochlea. Histological findings.
Acta Otolaryngol (Stockh) 89(3-4), pp. 317-322.

Lipscomb, D.M. (1980).
Noise and occupational hearing impairment.
Ear Nose Throat J 59(6), pp. 243-249.

Lomov, O.P., Autiunian, S.I. (1981).
[Effect of intermittent noise on central nervous system/function.]
Voen Med Zh 7, pp. 44-46.

Long, J.G., Lucey, J.F., Philip, A.G. (1980).
Noise and hypoxemia in the intensive care nursery.
Pediatrics 65(1), pp. 143-145.

Mabry, J.E., Carey, R.B. (1980).
An analysis of community complaints to air force aircraft noise.
Man-Acoustics and Noise, Inc., Seattle, Wa.

Man, A., Naggan, L. (1981).
Characteristics of tinnitus in acoustic trauma.
Audiology 20(1), pp. 72-78.

Mäntysalo, S., Vuori, J. (1980).
Hearing threshold measurements of workers exposed to impulse noise.
Scand Audiol [Suppl] Suppl 12, pp. 273-281.

Maslen, K.R. (1980).
Towards a better understanding of temporary threshold shift or hearing.
Royal Aircraft Establishment, Farnborough, England.

Medina, J.E., Drescher, D.G. (1981).
The amino-acid content of perilymph and cerebrospinal fluid from guinea pigs and the effect of noise on the amino-acid composition of perilymph.
Neuroscience 6(3), pp. 505-509.

Meecham, W.C. (1978).
Aircraft noise and the community.
Conference proceedings held at University of California, Los Angeles, September, 1978.

Menyakin, R.P., Poperetskaya, V.I. (1980).
Occupational changes in the organ of hearing and equilibrium in sailors and fisherman.
translation from Vestn Otorinolaringol (USSR) 1, pp. 39-42, 1980.

Meyer, C., Biedermann, M. (1980).
Immediate alterations in the impulse noise exposed organ of Corti of the guinea pig.
Acta Otolaryngol (Stockh) 90(3-4), pp. 250-256.

Miller, M.H., Doyle, T.J., Geier, S.R. (1981).
Acoustic neurinoma in a population of noise exposed workers.
Laryngoscope 91(3), pp. 363-371.

Mills, J.H., Adkins, W.Y., Gilbert, R.M. (1981).
Temporary threshold shifts produced by wideband noise.
J Acoust Soc Am 70(2), pp. 390-396.

Mocanu, D., Mihail, G., Stratulat, E., Vasilov, M., Branisteanu, G. (1979).
[Predictive value of temporary reduction of the hearing threshold in experimental conditions of exposure to noise.]
Rev Igiena Bact Vir Paraz Epidem Pneum 28(4), pp. 335-340.

Monaenkova, A.M., Gladkova, E.V., Radionova, G.K., Shatskaya, N.N. (1980).
[Results of a comprehensive study of cardiovascular diseases among workers of the principal occupations of the foundry industry.]
Gig Tr Prof Zabol 4, pp. 4-7.

Morimitsu, T., Hagiwara, T., Ide, M., Matsumoto, I., Okada, S. (1980).
Effect of intermittent sound stimulation on cochlear microphonics and the possible preventive effect of coenzyme Q10.
Hear Res 3(2), pp. 155-166.

Nakamura, K., Komoike, Y., Horiguchi, S. (1980).
[Changes of audiogram on some glass manufacturers.]
Sumitomo Sangyo Eisei 0(16), pp. 19-28.

National Aeronautics and Space Administration (1981).
Annoyance caused by light aircraft noise.
translation of "Stoerwirkungen durch den laerm den kleinaviatik", Switzerland, 1980, pp. 1-132.

Nawrot, P.S., Cook, R.O., Staples, R.E. (1980).
Embroytoxicity of various noise stimuli in the mouse.
Teratology 22(3), pp. 279-289.

Nilsson, R., Borg, E., Lidén, G. (1980).
Fatigability of the stapedius reflex in industrial noise.
Acta Otolaryngol (Stockh) 89(5-6), pp. 433-439.

Nilsson, P., Erlandsson, B., Hakanson, H., Ivarsson, A., Wersäll, J. (1980).
Morphological damage in the guinea pig chochlea after impulse noise and pure tone exposures.
Scand Audiol [Suppl] Suppl 12, pp. 155-162.

Occupational Safety and Health Administration (1981).
Hearing conservation amendment to the standard for occupational exposure to noise.
Occupational Safety and Health Administration, Washington, D.C.

Office of Radiation Programs (1980).
Evaluation of health and environmental effects of extra high voltage (EHV) transmission.
Office of Radiation Programs, Washington, D.C.

Orloske, A.J., Leddo, J.S. (1981).
Environmental effects on children's hearing: how can school systems cope?
J Sch Health 51(1), pp. 12-14.

Osada, Y. (1980).
Community reactions to aircraft noise in the vicinity of airport: a comparative study of the social surveys using interview method.
translation of Koshu Eiseiin Kenkyu Hokoku (Tokyo) 1971.

Otto, B., Klajman, S., Koldej, E., Otto-Sternal, W. (1980).
An analysis of the relation between dysphonia in shipyard workers and working in noise.
Bull Inst Marit Trop Med Gdynia 31(3-4), pp. 185-192.

Palamarek, D.L., Rule, B.G. (1979).
The effects of ambient temperature and insult on the motivation to retaliate or escape.
Motiv Emotion 3(1), pp. 83-92.

Pearsons, K.S., White, P.H., Whilby, J.F. (1980).
Evaluation of the noise impact of satellite power system vehicles on the community and ecology at the launch site. Summary report.
Bolt, Beranek and Newman, Inc., Canoga Park, Ca.

Penner, M.J. (1980).
Two-tone forward masking patterns and tinnitus.
J Speech Hear Res 23(4), pp. 779-786.

Perez Morales, R., Martin, L., Oliva, A. (1980).
[Clinical significance of noise in occupational medicine.]
Rev Cubana Hig Epidemiol 18(1), pp. 13-20.

Peterson, E.A., Augenstein, J.S., Tanis, D.C., Augenstein, D.G. (1981).
Noise raises blood pressure without impairing auditory sensitivity.
Science 211(4489), pp. 1450-1452.

Pierzchala, K., Sroczynski, J., Kazibutowska, Z. (1981).
[Neurological and electromyographical evaluation of the health status of workers exposed to occupational noise.]
Pol Tyg Lek 36(23), pp. 829-831.

Pop, M., Fabian, N. (1980).
Effect of a noise emitted in a chronic and acute manner of the behaviour and Sulfhydryl groups of blood and brain in white rats.
Stud Univ Babes-Bolyai Biol 25(2), pp. 58-63.

Powell, C.A. (1979).
Laboratory study of annoyance to combined airplane and road traffic noise.
National Aeronautics and Space Administration, Langley Research Centre, Hampton, Va.

Powell, C.A. (1979).
A summation and inhibition model of annoyance resonse to multiple community noise sources.
National Aeronautics and Space Administration, Langley, Research Centre, Hampton, Va.

Price, G.R. (1979).
Loss of auditory sensitivity following exposure to spectrally narrow impulses.
J Acoust Soc Am 66(2), pp. 456-465.

Price, G.R. (1981).
Implications of a critical level in the ear for assessment of noise hazard at high intensities.
J Acoust Soc Am 69(1), pp. 171-177.

Raichel, D.R. (1980).
Recreational noise exposure - an occupational hazard for audio engineers.
J Audio Eng Sci 28(2), pp. 896-899.

Razveikin, S.V., Stolbun, B.N., Karagodina, I.L., Surinovich, I.S., Berenshtein, I.A., Dzhiga, K.F. (1980).
[Effect of intense aircraft noise on the cardiovascular system of humans.]
Gig Sanit 0(5), pp. 12-14.

Reinhardt, F., Lohse, M. (1980).
[The physiologic working capacity of the students with considerations on their living conditions in a university.]
Clujul Medical 53(2), pp. 144-146.

Reinis, S., Featherstone, J.W., Weiss, D.S. (1980).
The effects of sonic booms on hearing and inner ear structures.
Scand Audiol [Suppl] Suppl 12, pp. 163-169.

Riikangas, P., Anttonen, H., Hassi, J., Sorri, M. (1980).
Hearing loss and impulse noise during military service.
Scand Audiol [Suppl] Suppl 12, pp. 292-297.

Robertson, D., Johnstone, B.M. (1980).
Acoustic trauma in the guinea pig cochlea: early changes in ultrastructure and nerual threshold.
Hear Res 3(2), pp. 167-179.

Rohrmann, B. (1981).
Disturbance to the population due to flight operations at landing fields.
translation of "Die gestoertheit des bevolkerung durch den flugbetrieb auf landeplaitzen." Hamburg, 1975.

Rosenman, K.D. (1979).
Cardiovascular disease and environmental exposure.
Br J Ind Med 36(2), pp. 85-97.

Salvi, R., Henderson, D., Hamernick, R.P., Parkins, C. (1980).
VIII. Nerve response to click stimuli in normal and pathological cochleas.
Hear Res 2(3-4), pp. 335-342.

Sandén, A., Axelsson, A. (1981).
Comparison of cardiovascular responses in noise-resistant and noise-sensitive workers.
Acta Otolaryngol [Suppl] (Stockh) 377, pp. 75-100.

Scheidt, R., Brückner, C. (1981).
[Extra-aural effect of noise - a literature review on the current state of knowledge.]
Z Gesamte Hyg 27(10), pp. 733-738.

Schmidt, D.R. (1979).
Noise levels and crew noise exposure aboard US merchant vessels. Data measured on seven ships during normal cruising.
Naval Ocean Systems Center, San Diego, Ca.

Scholz, R.C., Leazer, L.D. (1980).
Proceedings of the Symposium on Occupational Health Hazard Control Technology in the Foundry and Secondary Non-ferrous Smelting Industries.
held at Chicago, Illinois, Dec. 1979.

Schuschke, G. (1980).
[The role of communal noise in the theory and practice of medical protection of the environment.]
Zh Ges Hyg Grenz 26(9), pp. 647-652.

Shields, W.D. (1979).
Noise hazards in the practice of dentistry.
Army Institute of Dental Research, Washington, D.C.

Shitskova, A.P. (1979).
[Hygenic aspects in prevention of cardiovascular pathology.]
Gig Sanit 0(3), pp. 3-5.

Shitskova, A.P. (1981).
[Effect of urban noise on public health.]
Vestn Akad Med Nauk SSR (3), pp. 66-76.

Silverstein, L.D., Graham, F.K., Calloway, J.M. (1980).
Preconditioning and excitability of the human orbicularis oculi reflex as a function of state.
Electro Clin Neurophys 48(4), pp. 406-417.

Simeonova, G. (1980).
[A study of the effect of traffic noise at 60 dBA equivalent level on certain mental working capacity indicators in various age groups.]
Folia Med (Plovdiv) 22(3), pp. 24-29.

Singh, I.L., Dwivedi, C.B., Sinha, M.M. (1980).
Phasic arousal and vigilance.
Percept Mot Skills 50(3 part 1), p. 798.

Smoorenburg, G.F., Vanheusden, E. (1978).
Effects of acute noise traumata on whole-nerve and single unit activity.
presented at 15th Workshop on Inner Ear Biol., Seefeld, Austria.

Stewart, J., Eikelboom, R. (1979).
Stress masks the hypothermic effect of Naloxone in rats.
Life Sciences 25(13), pp. 1165-1172.

Stupfel, M., Molin, D., Thierry, H., Busnel, M.C. (1980).
Respiratory activity variations induced in groups of LD 12:12 synchronized Sprague-Dawley rats by a 100 dB white noise emitted at 12-h intervals.
Chronobiologia 7(3), pp. 337-342.

Sugawara, H., Aoyagi, F., Abe, K. (1979).
The electro-encephalogram in Ruminants 10. Effects of noise on the electro-encephalogram and lactation in goats.
Iwate Daigaku Nogakubu Hokoku 14(4), pp. 319-336.

Sulkowski, W.J. (1980).
Industrial noise pollution and hearing impairment, problems of prevention, diagnosis and certification criteria.
translation of Polish journal. National Science Foundation, Washington, D.C.

Sulkowski, W.J., Lipowczan, A. (1979).
Impulse noise induced hearing loss in drop-forge operators.
in Proceedings of the International Conference on Noise Control Engineering, Inter-Noise 79 Vol 2, pp. 887-890.

Syka, J., Popelar, J. (1980).
Hearing threshold shifts from prolonged exposure to noise in guinea pigs.
Hear Res 3(3), pp. 205-213.

Theorell, T., Vigborg, A., Kallner, A., Dahlen, G., Walinder, O. (1980).
A comparison between Finnish immigrants and native Swedes in the greater Stockholm region Sweden. Social and medical risk indicators of ischemic heart disease.
Scand J Soc Med 8(3), pp. 105-115.

Thomas, G.B., Williams, C.E., Hoger, N.G. (1980).
The relationship between selected non-auditory measures and the hearing threshold levels of an aviation noise-exposed population.
Naval Aerospace Medical Research Lab, Pensacola, Fl.

Tillaev, S.R. (1979).
[Physiological and hygienic evaluation of working conditions and morbidity among workers engaged in the manufacture of tin cans.]
Gig Tr Prof Zabol 0(9), pp. 47-49.

Tolonen, M., Hassi, J., Vaaranen, A., Kolivuori, T., Heikkila, P., Hietanen, M., Kakko, K., Yrjanheikki, E. (1980).
Work related medical surveillance in small workplaces.
Scand J Work Environ Health 5(Suppl 2), pp. 41-44.

Voigt, P., Godenhielm, B., Ostlund, E. (1980).
Impulse noise-measurement and assessment of the risk of noise induced hearing loss.
Scand Audiol [Suppl] Suppl 12, pp. 319-325.

Wanner, H.U., Wehrli, B., Nemecek, J., Turrian, V. (1980).
Annoyance due to noise and air pollution to the residents of heavily frequented streets.
translated from Sozial und Praeventivmedizin, Zurich, 22, pp. 108-122, 1977.

Ward, W.D. (1980).
Effects of impulse noise on hearing. Summary and overview.
Scand Audiol [Suppl] Suppl 12, pp. 339-348.

Wehrli, B., Nemecek, J., Turrian, V., Hoffman, R., Wanner, H. (1980).
Effects of street traffic noise in the night.
Translation from Kampf der Laerm, 25, pp. 138-149, 1978.

Woodford, C.M. (1981).
Noise-induced hearing loss.
Occup Health Saf 50(3), pp. 62, 64-65, 67-68.

Yamanaka, K., Nakagawa, T., Kobayashi, F., Kanada, S., Tanahashi, M., Muramatsu, T., Yamada, S. (1980).
[Hygienic studies of the Shinkansen super express railway noise and vibration in residential areas.]
Nagoya Igaku 103(1-2), pp. 88-110.

Yokoo, V., Sebayashi, T. (1981).
[Effects of chronic exposure to railway noises on thinking process of school children.]
Nippon Eiseigaku Zasshi 35(6), pp. 841-850.

Zakrisson, J.E., Borg, E., Lidén, G., Nilsson, R. (1980).
Stapedius reflex in industrial impact noise: fatigability and role for temporary threshold shift (TTS).
Scand Audiol [Suppl] Suppl 12, pp. 326-334.

Zubick, H.H., Tolentino, A.T., Boffa, J. (1980).
Hearing loss and the high speed dental handpiece.
Am J Public Health 70(6), pp. 633-635.

Appendix A(iv)

Bibliography of Other Relevant Material - Infrasound

Note: Titles in square brackets [ ] indicate a translation of the title of a non-English article.

Atherley, G.R. (1969).
Infrasonics.
Proc R Soc Med 62(2), pp. 112-113.

Bachurina, T.I. (1974).
[Effect of short-term infrasonic stimuli on the brain bioelectric activity.]
Fiziol Zh SSSR 60(4), pp. 491-498.

Balabanov, A.A., Beigel, M.Z., Zelikman, M.K.H., Portnoi, Iu.V., Stepanov, B.M. (1980).
Reaction of guinea pigs to infrasonic vibration velocity.
Biofizika 25(2), pp. 323-325.

Birecki, W. (1980).
[Effect of infrasounds on human organism.]
Otolaryngol Pol 34(2-3), pp. 243-247.

Busnel, R.G., Lehmann, A. (1977).
Synergistic effects of infrasonic noise and ethanol on measurable behaviour.
CR Acad Sci 285(4), pp. 423-425.

Busnel, R.G., Lehmann, A.G. (1978).
Infrasound and sound, differentiation of their psycho-physiological effects through use of genetically deaf animals.
J Acoust Soc Am 63(3), pp. 974-977.

Chung, D.Y., Gannon, R.P. (1980).
Clinical records. Hearing loss due to noise trauma.
J Laryngol Otol 94(4), pp. 419-423.

Cook, R.K. (1974).
Colloquium on infrasound in Paris.
J Acoust Soc Am 56(2), pp. 721-722.

Cook, R.K., Bedard, A.J. (1971).
On the measurement of infrasound.
Geophysical Jnl of the Royal Astronomical Society 26, pp. 5-11.

Doroshenko, P.N., Bazarov, V.G., Palgov, V.I. (1977).
[Condition of vestibular function in compressor operators exposed to infrasound and stable noise.]
Zh Ushn Nos Gorl Bolezn 3, pp. 54-59.

Fasbender, J. (1980).
[Research on directional location of moving infrasound sources-measurements on jet aircraft.]
Acustica 45(3), pp. 169-174.

Fecci, R., Barthelemy, R., Bourgoin, J., Mathias, A., Eberle, H., Moutel, A., Jullien (1971).
[The action of infrasonic waves on the body.]
Med Lav 62(2), pp. 130-150.

Gabovich, R.D., Shutenko, O.I., Kozyarin, I.P., Shvaiko, I.I. (1979).
[Effects from combined exposure to infrasound and ultra high frequency electro magnetic fields in an experiment.]
Gig Sanit 0(10), pp. 12-14.

Gabovich, R.D., Shutenko, O.I., Krechkovskii, E.A., Shmuter, G.M., Stechenko, L.A., Andreenko, T.V., Bychenko, I.G., Kolesova, N.A., Murashko, V.A. (1979).
[Effect of infrasound on the processes of bioenergetics, ultrastructure of organs and some processes of regulation.]
Gig Tr Prof Zabol 3, pp. 9-15.

Handel, S., Jansson, P. (1974).
[Infrasound-occurrence and effects.]
Lakartidningen 71(6), pp. 1635-39.

International Colloquium on Infrasound (1973).
International Colloquium on Infrasound.
National Centre of Telecommunication Studies. France.

Ising, H., Shenoda, F.B., Whittke, C. (1980).
[Infrasound effect on humans.]
Acustica 44(3), pp. 173-181.

Izmerov, N.F., Korbakova, A.I. (1977).
[The state of the problem of hygienic normalization of adverse factors of the industrial environment in the USSR].
Gig Sanit 11, pp. 42-46.

Johnson, D.L., von Gierke, H. (1974).
Audibility of infrasound.
J Acoust Soc Am 56(Suppl), p. S37.

Karpova, N.I., Alekseev, S.V., Kodyskin, A.V., Suvorov, G.A., Malyshev, E.N. (1972).
[Experimental Study of the effect of infrasonic oscillations on the human body.]
Gig Tr Prof Zabol 16(7), pp. 36-38.

Krukowski, B., Carlborg, B., Densert, O. (1980).
Nonlinear aspects of infrasonic pressure transfer into the perilymph.
Hear Res 2(3-4), pp. 207-212.

Lehmann, A.G., Busnel, R.G. (1979).
Reduction of swimming time in mice through interaction of infrasound and alcohol.
Psychopharmacology (Berlin) 65(1), pp. 79-85.

Lemke, M., Willumeit, H.P. (1980).
Measurements of interior noise in vehicles in the infrasound and hearing range.
in Proceedings of Int. Assoc. for Veh Syst Dyn Symposium, Sept. 3-7 1979, pp. 211-222.

Malyshev, E.N., Skorodumov, G.E. (1974).
[The infrasound effect on the body.]
Gig Sanit 3, pp. 27-30.

Marullo, T., Collatina, S. (1968).
[Preliminary findings on auditory fatigability by stimulation with high level infrasonic mechanical energy applied exclusively to the ear.]
Valsalva 44(5), pp. 222-226.

Matkowska, W.I. (1975).
[Infrasound therapy.]
Pol Tyg Lek 30(2), pp. 79-80.

Mullen, M.A. (1975).
Infrasound retards development of Tribolium-castaneum and Tribolium-confusum.
Journal of Stored Products Research 11(2), pp. 111-114.

Mullen, M.A. (1976).
Progeny produced by Oryzaephilus-surinamensis and Oryzaephilus-mercator (Coleoptera: Cucujidae) and by Callosobruchus-maculatus (Coleoptera: Bruchidae) during continuous exposure to infrasound.
Journal of the Georgia Entomological Society 11(1), pp. 1-4.

Niedzwiecki, A., Ribner, H.S. (1979).
Subjective loudness and annoyance of filtered N-wave sonic booms.
J Acoust Soc Am 65(3), pp. 705-707.

Okai, O., Saito, M., Taki, M., Mochizuki, A., Fujio, N., Nishiwaki, N., Mori, T. (1978).
Body response to infrasound.
J Acoust Soc Am 64(Suppl 1), p. S128.

Palgov, V.I., Doroshenko, P.N. (1975).
[Combined effects of infrasound and stable noise on the hearing function by workers in compressor shops.]
Zh Ushn Nos Gorl Bolezn (1), pp. 22-28.

Petounis, A., Spyrakis, C., Varonos, D. (1977).
Efects of infrasound on activity levels of rats.
Physiology and Behaviour 18(1), pp. 153-155.

Petounis, A., Spyrakis, C., Varonos, D. (1977).
Effects of infrasounds on the conditioned avoidance response.
Physiology and Behaviour 18(1), pp. 147-151.

Petrovic, D. (1980).
[Ultrasound and infrasound in pilots' cabins in commercial aircraft.]
Vojnosanit Pregl 37(4), pp. 239-244.

Petrovic, D., Drazic, A., Basaric, G., Giser, A., Kitanovic, N. (1981).
[Infrasound, ultrasound and noise in combat and non-combat vehicles of the Yugoslav Army.]
Vojnosanit Pregl 38(5), pp. 337-341.

Safonov, M. Yu. (1979).
[Histo enzymatic characteristics of the myocardium during the effect of infrasound.]
Gig Tr Prof Zabol 0(12), pp. 52-55.

Sanova, A.G. (1975).
[Combined effect of low-frequency noise and infrasound on the body of workers.]
Vrach Delo (10), pp. 133-136.

Shcheglov, A.G., Baranov, E.M. (1972).
The effect of infrasound on the functional state of cells in the central nervous system and some internal organs.
Tr Lenin Sanit 97, pp. 79-82.

Shutenko, O.I., Gabovich, R.D., Krechkovskii, E.A., Murashko, V.A., Stechenko, L.A. (1979).
[Effect of infrasound of varying intensity on the body of experimental animals.]
Gig Sanit 0(3), pp. 19-25.

Spyraki, C., Papadopoulou-Daifoti, Z., Petounis, A. (1978).
Norepinephrine levels in rat brain after infrasound exposure.
Physiology and Behaviour 21(3), pp. 447-448.

Spyraki, C., Papadopoulou, Z., Zis, B., Varonos, D. (1980).
Effects of diazepam infrasounds combination on loco motor activity and avoidance behaviour of rats.
Pharmacology, Biochemistry and Behaviour 12(5), pp. 767-772.

Sudzilovskii, F.V., Zagorskii, Yu, M. (1974).
State of some rabbit nervous system parts after exposure to infrasound.
Arkhiv Anatomii, Gistologii I Embriologii 66(6), pp. 31-35.

Suvorov, G.A., Evdokimova, E.B., Denisov, E.I., Shaipak, E.Iu. (1981).
[Hygienic standard for infrasound in industry.]
Gig Tr Prof Zabol 9, pp. 8-11.

Syracuse Research Corporation (1980).
Information profiles on potential occupational hazards. Volume III. Industrial processes. Infrasonics.
Report for National Institute for Occupational Safety and Health, Pockville, Md.

Takeda, S. (1980).
[The effects of infrasonic noise on man.]
Sumitomo Bull Ind Health 16, pp. 1-10.

Thiessen, G.J. (1976).
Effects of noise on man.
National Research Council, Ottawa, Canada.

Williams, D., Tempest, W. (1975).
Noise in heavy goods vehicles.
J Sound Vib 43(1), pp. 97-107.

Wysocki, K., Schultz, K., Wieg, P. (1980).
[Influence of infrasonic pressure on man.]
Z Gesamte Hyg 26(6), pp. 436-440.

Yamamura, K., Kishi, R. (1980).
Effects of infrasound on the rota-rod treadmill performance of rats.
Eur J Applied Physiol 45(1), pp. 81-86.

Appendix B

LITERATURE ASSESSMENT FORM

Author ____________________________________

Title ____________________________________

____

____

Abstract

1. Health Effects
   - Yes ____
   - No ____
   - Maybe ____

2. Problem Statement
   - Clear ____
   - Vague ____
   - Absent ____

3. Research Setting
   - Lab. ____
   - Field ____
   - Human ____
   - Animal ____

4. Sample Design
   - Explicit: Yes ____ No ____
   - Health Status: Reported ____ Not Reported ____
   - Sample Size N(s) = ____
   - Response Rate: Reported ____ Not Reported ____
   - Biases ____________________

     ____

5. Experimental Measure

Type of Noise	______
Descriptor	______
Level	______
Duration	______
Measurement	______
	______

6. Compliance

Applicable	______
Not Applicable	______

7. Confounding Factors ______

______

8. Outcome Measurement ______

______

______

______

Physiological		____
Pathological		____
Appropriate		____
Inappropriate		____
Subjective		____
Objective		____
Sensitive		____
Insensitive		____
Valid		____
Invalid		____
Reliable		____
Unreliable		____
Blind	Yes	____
	No	____
Rigourous	Yes	____
	No	____

9. Analysis

Replicable Yes ____
No ____

Statistics ______________________________
____

Valid ____
Invalid ____

Results ______________________________
____
____
____
____
____

10. Interpretation

Conclusions ______________________________
____
____
____
____
____

Interpretation by Author Justified ____
UnJustified ____

Generalizability ______________________________

11. Study Class ______________________________

12. Overall Comments ______________________________
____
____
____
____

Appendix C

Summary of Assessment Results

To provide a standardized evaluation, each paper was rated on three major criteria: noise exposure; health outcome measurement; study design and analysis. The items used to score each paper on these criteria are listed below. The total score obtained on each criterion is reported in the Evaluation column of the summary table. The scores provide a standardized measure of the strengths of each paper relative to the other papers.

Noise:

Type	specified = 1	unspecified = 0
Descriptor	specified = 1	unspecified = 0
Level	specified = 1	unspecified = 0
Duration	specified = 1	unspecified = 0
Measurement procedure	specified = 1	unspecified = 0
Realistic	yes = 1	no = 0

Maximum score = 6

Health:

Health effect	yes = 2 maybe = 1	no = 0
Outcome	pathological = 2 physiological = 1 psychological/task = 0	
Appropriate	yes = 1	no = 0
Objective	yes = 1	no = 0
Sensitive	yes = 1	no = 0
Valid	yes = 1	no = 0
Reliable	yes = 1	no = 0
Blind	yes = 1	no = 0
Regorous	yes = 1	no - 0

Maximum score = 11

Design and Analysis:

Type	randomized clinical trial/ cohort analytic = 3 case control/descriptive analytic = 2 laboratory/descriptive = 1 other = 0	
Problem statement	clear = 1	vague/absent = 0
Design explicit	yes = 1	no = 0
Health status	yes = 1	no = 0
Sample size	large = 1	small = 0
Response rate	yes = 1	no = 0
Bias	no = 0	yes = 1
Replicable	yes = 1	no = 0
Statistics	yes = 1	no = 0
Valid	yes = 1	no = 0

Maximum score = 12

Noise

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Alberti, P.W., Symons, F., Hyde, M.L. 1979	industry Ontario	case study	"to investigate the significance of this physical sign (asymmetrical hearing loss) in the context of the quasi-medico-legal setting of pension assessments."	asymmetrical hearing loss	100 patients referred by Workmans Compensation board of Ontario with asymmetrical hearing loss.	categorized according to industry type
Ambasankaran, M., Brahmachari, D., Chadda, V.K., Phadnis, M.G., Raju, A., Ramamurthy, A., Shah, V.R. 1981	industry India	descriptive analytic	"to monitor the noise level ... and to measure the hearing level of those exposed ..."	hearing loss	209 control 51 air conditioning plant 15 glass blowing shops	A/C plant: 72-100 dBA low frequency continuous glass blowing plant: 70-116 dBA high frequency intermittent
Andren, L., Hansson, L., Björkman, M., Jonsson, A. 1980	lab recorded industrial noise	laboratory study	"to establish whether exposure to noise at levels which frequently occur in occupational life may cause a rise in BP also in man ...	cardiovascular	18	40, 75, 85, 95 dBA 10 or 20 min.
Arnoult, M.D., Voorhees, J.W., 1980	lab recorded aircraft noise	laboratory study	"whether there is any difference in the extent to which impulsive and non-impulsive noises actually interfere with performance on a representative audiovisual task."	task performance	30	24 different flyover conditions 10 min.
Bättig, K., Zeier, H., Müller, R., Buzzi, R. 1980	airport Switzerland	descriptive	"...to investigate possible autonomic noise responses of airport area residents in their private homes..."	physiological	33	30-65 NNI 45 min.
Cohen, S., Evans, G.W., Krantz, D.S., Stokols, D. 1980	school children aircraft noise California	descriptive analytic	To explore the relationship between aircraft noise exposure and a number of cognitive, motivational and physiological measures.	- physiology - task performance	142 noisy 120 quiet	control: mean peak 56 dBA noisy: mean peak 74 dBA 300 flights/day

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
% of patients whose AHL could be attributed to various causes	descriptive	many possible including: nonrespondent bias noncompliance bias other exposures	"workplace noise does in fact produce asymmetrical hearing loss in a significant percentage of patients and that its presence should not disqualify them from pension award."	Noise: 2 Health: 5 Design and Analysis: 6
• % of sample having hearing impairment • median hearing threshold for various frequencies	descriptive	- duration of exposure - other exposures	"seems to indicate that the intense low frequency noise affects the hearing level at all frequencies."	Noise: 4 Health: 6 Design and Analysis: 4
average: • systolic, diastolic blood pressure • stroke volume - heart rate - peripheral resistance	t-test	volunteer bias	- sig. increase in diastolic b.p. at 95 dBA - no increase in systolic b.p. - sig. rise of total peripheral resistance at 95 dBA - no increase in heart rate - no increase in stroke volume	Noise: 5 Health: 6 Design and Analysis: 5
number of errors, unheard, and failures in correct/incorrect designation of word description	regression	speech interference	No support for the assumption that impulsive noise is more annoying or interfering than nonimpulsive noise.	Noise: 4 Health: 2 Design and Analysis: 4
for every 20 sec: - number of respiratory movements - number and amplitude of skin-conductance changes - average pulse rate - 6 N-responses while doing various Activities	correlation Chi-square	- volunteers selected by an anti-noise group	"effects of noise were modest" - vegetative responses did not habituate - effect of noise was less than that of mental activity	Noise: 4 Health: 6 Design and Analysis: 3
- average systolic and diastolic blood pressure - absenteeism - persistence on task after previous success/failure - distractibility on task - school achievement	regression multivariate F	- controlled for age, social class, race, length of residence - different schools and teachers for noise and quiety situations - mobility differences for 2 groups	- significant differences in general health, blood pressure - noise-school children attended school more - no difference in school achievement, attentional strategy - persistence at puzzle solving less in noisy area	Noise: 4 Health: 7 Design and Analysis: 8

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Fullenius, M., Brandenberger, G., Lecornu, C., Simeoni, M., Reinhardt, B. 1980	lab pink noise	laboratory experiment	"to investigate the possible immediate effects of noise exposure on circulating epinephrine, norepinephrine, and dopamine ... plasma ACTH, cortisol, and GH were analysed simultaneously ..."	biochemical	7 (own controls)	99 dBA intermittent 2 hours
Fruhstorfer, B., Hensel, H. 1980	lab white noise	laboratory experiment	"to examine the problem of noise adaptation under more rigidly controlled conditions ..."	physiological	13	100 dBA 12 x 16 sec. within 1 hour for 10 or 21 days
Harris, C.S., Shoenberger, R.W. 1980	lab white noise	laboratory experiment	"to determine the single and combined effects of 100 dBA broadband noise and complex waveform vertical vibration on cognitive performance."	task performance	12	65,100 dBA 3 x 10 min.
Ising, H., Dienel, D., Günther, T., Markert, B. 1980	lab recorded road traffic noise	laboratory experiment	"...laboratory study of the combined effect of mental load and noise."	task performance	57 (own controls)	control <50 dBA Leq noise 85 dBA Leq 7 hours
Jenkins, L., Tarnopolsky, A., Hand, D. 1981	from records of 3 psychiatric hospitals London	descriptive analytic	To compare mental hospital admission rates for areas exposed and not exposed to aircraft noise	mental health	9,000	<35, 35-44, 45-54, >55 NNI from noise contours
Johnson, D.W., Hammond, R.J., Sherman, R.E. 1980	ambulance cab noise Minnesota	field survey	"to determine effects of noise exposure on our ambulance service paramedics."	hearing loss	56	96-102.5 dBA average 16-22 min. each day
Jones, D., Broadbent, D. 1979	lab recorded office noise	laboratory study	evaluation of costs (psychological) involved in coping with speech interference	psychological effects	32	55, 80 dBC 30 minutes

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
levels of: plasma epinephrine norepinephrine dopamine ACTH cortisol GH urinary epinephrine norepinephrine dopamine	t-test		- no difference in plasma urinary catecholamine levels - no difference in plasma GH or ACTH - significant change in pattern of cortisol throughout the day "noise alone does not give rise to important endocrinological changes in well informed volunteer human subjects."	Noise: 4 Health: 5 Design and Analysis: 6
respiration-amplitude and frequency heart rate cutaneous blood-flow EEG	not specified	volunteer bias	respiration - no change in amplitude - frequency change varies heart rate - no change over time blood flow - vascular response decreased over time EEG - activity changed over time "a general statement about hysiological noise adaptation is not possible."	Noise: 4 Health: 6 Design and Analysis: 5
total responses, early responses, late responses, percent correct for complex counting task	ANOVA (4 way) t-tests	volunteer bias vibration-separated out	- 100 dB resulted in worse performance than 65 dB. - vibration & 65 dBA produced an adverse effect. - performance at 100 dB worse without vibration than with vibration - performance deteriorated as a function of time.	Noise: 4 Health: 6 Design and Analysis: 7
performance - failures - quality - achievement blood circulation - pulse - systolic b.p. - diastolic b.p. 10 biochemical parameters	Wilcoxon nonparametric correlation		- some significant results. - increases in blood pressure did not change over time.	Noise: 5 Health: 6 Design and Analysis: 5
admission rates to psychiatric hospitals	multivariate log-linear methods	- looked at interaction with socio-economic variables - self selection	- no common pattern of admission across 3 hospitals - positive associations for some groups. "effects of noise, if any, could only be small, weakly influencing other causal variables but not overriding them."	Noise: 4 Health: 8 Design and Analysis: 8
comparison of hearing levels to normative values.	difference of means test	length of service	"pattern of hearing loss present ...was suggestive of noise exposure etiology."	Noise: 3 Health: 7 Design and Analysis: 6
% error detection, speed in proof reading task stroop test (index of interference) mood adjective check list	Wilcoxon		no effect on Stroop test. some composite psychological factors were significant	Noise: 5 Health: 5 Design and Analysis: 6

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Knipschild, P., Meijer, H., Sallé, H. 1981	aircraft noise (mother) Amsterdam	descriptive analytic	the relationship between aircraft noise and birthweight	birthweight	404 low noise 498 high noise	low <60-65 Ldn high 65-75 Ldn.
Knipschild, P., Sallé, H. 1979	cardiovascular screening program road traffic noise Netherlands	descriptive analytic	"whether people living in a street with much traffic (noise) run an increased risk of cardiovascular diseases."	cardiovascular	1342 quiet 399 noisy response rate 86%	quiet 55-60 Ldn noisy 65-70 Ldn
Kryter, K.D., Poza, F. 1980	lab recorded computer line printer noise	laboratory experiment	monitoring of physiological parameters and psychomotor task performance	task performance physiological	6 (own controls)	50,100 dBA 8 min. x 4
Kryter, K.D., Poza, F. 1980	lab pink noise	laboratory experiment	- effect of noise on physiological stress responses	physiological	24	67, 76, 92 dBA 8 min. x 4
Lees, R.E.M., Roberts, J.H. 1979	industry Ontario	descriptive analytic	"to look for evidence of a relation between hypertension and noise-induced hearing loss in the work force of a local industrial plant."	cardiovascular	62 exposed 62 control noise induced hearing loss a criteria for selection in exposed group.	exposed 95-98 control <85 dBA hearing loss used as surrogate for noise exposure
Lees, R.E.M., Romeril, C.S., Wetherall, L.D. 1980	industry Ontario	paired cohort historical prospective	"...to assess the effects of high noise level on incidence and type of morbidity and frequency of absenteeism, headaches and accidents."	cardiovascular general health	70 matched pairs	noisy > 90 dBA control < 85 dBA 3-15 years

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
incidence of birthweight categories (esp. < 3000 g)	t-test	self-selection socio-economic status length of exposure other exposures	proportion of birthweight <3000 g. for high noise area. - lack of biological sense (effect limited to female infants) - results are inconclusive	Noise: 4 Health: 5 Design and Analysis: 8
incidence of: cardiologist consultation hypertension angina pectoris ischaemia heart shape pathology	Fisher's Exact	- nonrespondent bias - self selection - length of residence	no significant differences "the question, whether traffic noise can increase the risk of contracting a cardiovascular disease, remains unanswered."	Noise: 4 Health: 8 Design and Analysis: 9
mean: - heart rate - peripheral pulse amplitude - peripheral blood volume number of errors in psychomotor task performance	not specified		- only pulse amplitude showed any effect "no trend in the physiological measures that would suggest that the noise had any particular "over arousal" or stress effect." - no effect on task performance	Noise: 4 Health: 6 Design and Analysis: 5
pulse amplitude skin temperature heart rate blood volume "epoch percentage score" - averaged over 20 secs.	difference of means test		- constriction of peripheral blood vessels increased with noise level - no change in heart rate, skin temperature	Noise: 4 Health: 5 Design and Analysis: 3
mean systolic and diastolic blood pressure incidence of hypertension	not specified	- matched for age and duration of employment - other exposures	- no significant difference between groups in mean systolic or diastolic blood pressure, or incidence of hypertension	Noise: 2 Health: 8 Design and Analysis: 6
incidence of: - ischaemic heart disease - peptic ulcer - diabetes mellitus - hypertension - myocardial infarction - mental illness - alcoholism - absenteeism - accidents - psychosocial disorders	analysis of variance	work shift controlled	- no significant relationship between noise level and absenteeism, headaches or accidents - unable to accept or reject hypothesis for specific medical conditions due to small sample size	Noise: 3 Health: 8 Design and Analysis: 9

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
LaVere, T.E. 1980	lab recorded sound	laboratory experiment	To compare individual reactions to auditory sound when asleep with reactions when awake. To find out whether sleep disruption necessarily involves behavioural awakening.	sleep disturbance	not reported	80 dBA various frequencies 15-30 secs duration for each occurrence
Lovallo, W.R., Pishkin, V. 1980	lab recorded sound	laboratory experiment	"effects of exposure to uncontrollable noise and task failure in Type A (coronary prone) and Type B (nonprone) men."	task performance	42	complex combination of sounds 15 min x 2
Moller, L. 1980	lab music white noise	laboratory experiment	"to determine what differences would occur in the performance of tasks by musicians while subjected to silence or intermittent noise stimuli."	task performance	30 2 x 10 exposed 10 control	I 55-80 dBA II 70 dBA 16 min. intermittent
Olaru, U.G. 1980	industry Nigeria	descriptive analytic	to determine if incidence of hearing loss is greater for noise-exposed workers than for non-exposed controls	hearing loss	61 exposed 90 control	95-115 dBA 3 months-17 years
Percival, L., Loeb, M. 1980	lab I recorded combination of sounds II - Glass & Singer noise - aircraft flyover peak combinations - normal aircraft flyovers - white noise	laboratory experiment	to replicate previous findings on the behavioural after effects of exposure to various noises	task performance	I 42 II 60	control 46 dBA experiment 95 dBA 24 min.
Pfander, F., Bongartz, H., Brinkmann, H., Kietz, H. 1980	weapons firing range Germany	descriptive analytic	To study the effect of impulse noise on hearing damage	temporary threshold shift	10,000	peak 154-186 dB 3-105 ms.

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
- amount of cortical desynchronization - reaction time task	descriptive		- response when awake is a poor predictor of response when asleep - total disruption time important	Noise: 2 Health: 6 Design and Analysis: 3
3 tasks - number of errors or time to solution - number of problems attempted	analysis of variance		Type A men did not exhibit stronger coping attempts than Type B men.	Noise: 4 Health: 6 Design and Analysis: 7
math test - correctness and speed index	analysis of variance		"no significant difference in performance between groups or between treated and control groups."	Noise: 4 Health: 5 Design and Analysis: 8
hearing threshold levels	not specified	- no ear protection - other exposures - respondent bias	- for every age group the exposed subgroup has a higher hearing level than the controls - hearing loss rate with duration increases after 7 years.	Noise: 3 1/2 Health: 8 Design and Analysis: 3 1/2
during exposure: % correct in tasks after exposure: number of attempts at insoluble puzzle	ANOVA (2 way)		I "noise had no effect on the tasks performed during exposure." - noise affected performance on a task performed later in quiet II - no significant differences between noise conditions - no significant differences between attempts at soluble puzzles - significantly fewer attempts at insoluble puzzles for Glass and Singer, and aircraft peak combination noises.	Noise: 5 1/2 Health: 6 Design and Analysis: 5 1/2
- TTS after 2 min. - recovery time	descriptive	all wore hearing protection	Exposures which were above CHABA'S permissible levels resulted in prolonged recovery time in less than 5% of subjects.	Noise: 4 1/2 Health: 9 Design and Analysis: 4

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Rai, R.M., Singh, A.P., Upadhyay, T.N., Patil, S.K.B., Nayar, H.S. 1981	industry India	descriptive analytic	"to evaluate the levels of a few biochemical parameters recognized as indices of stress..."	biochemical	exposed: 75 control: 35	88-107 dBA 10-15 years
Roche, A.F., Himes, J.H., Siervogel, R.M. 1979	ongoing study of school children Ohio	longitudinal study	To determine variation in patterns of change in thresholds with other factors	hearing loss	251	- noise scores from questionnaire - some dosimeter readings
Roevekamp, A., Passchier-Vermeer, W. 1978	lab white noise	laboratory experiment	"...the influence of noise exposure of longer duration on a number of parameters for blood circulation and respiration..."	cardiovascular	12 7 between 18-25 years old 5 between 45-55 years old	I 75-80 dBA II 90-95 dBA III intermittent IV traffic noise 73 dBA Leq 2 hours
Schori, T.R. Johnson, D.L. 1979	industry United States	Cohort analytic	To conduct an independent analysis of the Inter-Industry Noise Study	hearing loss	370 exposed 294 control	exposed 82-92 dB Leq control < 82 dB Leq 1-53 years
Smith, A.P., Broadbent, D.E. 1980	lab recorded sound	laboratory equipment	"...to investigate the effects of noise on another task involving relevant and irrelevant cues - the embedded figures task."	task performance	I 20 II 32	control 55 dBC noise 85 dBC
Standing, L., Stace, G. 1980	lab white noise	laboratory equipment	"What...are the effects of "mild" noise on "average" Ss who are exposed to it briefly in a fairly normal environment?"	anxiety level	14 quiet 15 noisy 16 very noisy	43, 61, 75 dB 30 min.

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
mean: - serum cortisol - serum proteins - total & free cholesterol - uric acid	Z statistic	controlled for age, length of exposure, activity level, nutritional status.	- free cholesterol higher in noise group - serum cortisol higher in noise group - 1 of 5 serum protein fractions higher in noise group - total cholesterol, uric acid significantly different "Thus it is conjectured that exposure to high intensity noise in man for a long duration...brings about biochemical changes which make him prone to cardiovascular pathology."	Noise: 4 1/2 Health: 7 Design and Analysis: 8
hearing threshold levels	Spearman rank correlation coefficients	controlled for sex, age	- children susceptible to noise damage - no significant relationship between noise scores and hearing thresholds, but trends for noisy events.	Noise: 1 1/2 Health: 9 Design and Analysis: 9
median value each 30 seconds for: - heart beat frequency - absolute impedance plethysmogram - diastolic and systolic blood pressure - pulse pressure - respiratory frequency	t-test		- increase in respiratory frequency, heart beat frequency, relative impedance - increases larger for older people - complete recovery after exposure - largest change caused by fluctuating levels (III) - little relationship between effects on physiological parameters and equivalent sound level	Noise: 5 Health: 7 Design and Analysis: 6
- hearing threshold at various frequencies	- analysis of covariance - multiple linear regression	- compliance with ear protection gear - losses over time	- Industrial noise levels of the exposed group increased hearing threshold at 4 kHz by about 6-7 dB.	Noise: 4 1/2 Health: 9 Design and Analysis: 8
mean number of figures completed. Task involves finding a simple figure embedded in a more complex one.	analysis of variance		- effect of noise not significant in experiment I and II	Noise: 5 Health: 6 Design and Analysis: 7 1/2
during exposure: - Eysenck Personality Inventory - Large-Thorndike Intelligence test after exposure: - State-trait anxiety inventory - IPAT objective anxiety test	ANOVA x^2	volunteer	- at highest noise levels anxiety increased significantly during exposure - anxiety scores did not increase after exposure to noise	Noise: 5 1/2 Health: 5 1/2 Design and Analysis: 5 1/2

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Stephenson, M.R., Nixon, C.W., Johnson, D.L. 1980	lab pink noise	laboratory experiment	"...to identify the minimum noise level capable of producing an asymptotic temporary threshold shift."	temporary threshold shift	12	65-80 dBA 24 hours
Sulkowski, W. 1980	drop forging industry Poland	descriptive analytic	to investigate hearing impairment caused by impulse noise	hearing loss	511 exposed 169 control	100.4, 114, 118.5 dBA Leq ≥ 30 years
Sumitsuji, N., Nanno, H., Kuwata, Y., Ohta, Y. 1980	lab recorded aircraft noise	laboratory experiment	Relationship between facial expression, sleeping stage, reaction and noise level	sleep disturbance	7	65, 75, 85 dBA 20-30 times/night 3 nights
Tarnopolsky, A., Watkins, G., Hand, D.J. 1980	domiciliary survey aircraft noise London	descriptive analytic	part of a survey to assess the associations between aircraft noise exposure and various indicators of psychiatric morbidity	general health	5885	< 35 NNI 35-44 NNI 45-54 NNI ≥ 55 NNI
Thackray, R.I., Touchstone, R.M. 1979	lab recorded control room sounds	laboratory experiment	"...examined the effect of noise... on the ability to sustain attention to a complex monitoring task	task performance	14 x 2 control 14 x 2 noise	78-80 dBA 2 hours
Trémolières, C., Hétu, R. 1980	lab impact noise	laboratory experiment	To measure temporary threshold shift as a function of various parameters of impact noise exposure.	temporary threshold shift	15	107-137 dB 20-200 ms. 60-1000 impacts repetition rate .25-2/sec.

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
temporary threshold shift measured during and after exposure	t-test		- reached asymptotic TTS after 8-16 hours - recovery within 24 hours - maximum TTS at 4 kHz - ATTS threshold level 75-80 dB "...prolonged exposure to broad-band noise with a sound level below 75 dB would be innocuous for populations regularly exposed to those or lower levels."	Noise: 5 Health: 6 Design and Analysis: 5
permanent hearing loss	not specified	matched for age	- hearing loss increases with length of employment and age - hearing impairment does not differ from steady state, but there is a wider spread of effect.	Noise: 5 1/2 Health: 9 Design and Analysis: 4 1/2
EMG amplitude EEG button pressing on awakening	not specified		- facial expression related to noise level - facial expression associated with EEG changes and button pressing - different strength of reaction depending on sleep stage - facial expression eliminated by third night	Noise: 5 Health: 6 Design and Analysis: 2
27 acute and chronic symptoms, eg. depression sore throat headaches sleep nervousness back pain from General Health Questionnaire	χ^2	- controlled for age and sex - nonrespondent bias - other socio-economic characteristics	- only burns/cuts/minor accidents, and tinnitus significantly higher in noisy areas - most chronic symptoms more prevalent in low noise areas "Noise is not a stressor precipitating symptoms, but rather an agent for sorting individuals into annoyance categories according to their vulnerability to stress."	Noise: 4 Health: 5 1/2 Design and Analysis: 5
- maximum, minimum, mean latency of detection of stimulus change in visual monitoring task - 2 difficulty levels - heart rate and heart rate variability	ANOVA χ^2		- no significant difference in latency or missed stimuli between noise levels - heart rate variability lower under noise - no effect on performance, but additional effort expended	Noise: 5 Health: 8 Design and Analysis: 5
temporary threshold shift - critical level 15 dB	χ^2 Wilcoxon		- significant effects of number of impacts, repetition rate, rise and decay times, duration - TTS not a linear function of Leq, but Leq could be used if put in terms of longest duration, highest repetition rate, largest number.	Noise: 5 1/2 Health: 7 Design and Analysis: 3 1/2

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Vernet, M. 1979	field experiment road and rail noise	descriptive	To measure reaction to train noise, the conditioning to noise over time, and to compare these with road noise.	sleep disturbance	10 rail 10 road	I rail 66-69 Leq road 67-69 Leq II rail 50 Leq road 50-55 Leq
Watkins, G., Tarnopolsky, A., Jenkins, L. 1981	domiciliary survey London airport	descriptive analytic	"...use of medicines, general practitioner services, hospital facilities and community services were investigated in relation both to the level of aircraft noise..."	general health	5885	< 35 NNI 35-44 NNI 45-54 NNI > 54 NNI
Willson, G.N., Chung, D.V., Gannon, R.P., Roberts, M., Mason, K. 1979	industry British Columbia	descriptive	To study the relationship between hearing loss and various health factors	hearing loss	85 workers petitioning Workman's Compensation Board for noise-induced hearing loss.	noise hazard rate based on occupational history
Yamamura, K., Aoshima, K. 1980	lab pink noise	laboratory experiment	to examine the effect of various levels and frequencies of trapezoidal noise on TTS and urinary 17 OHCS	temporary threshold shift biochemical	6-12	80, 90 dB peak various periods 8 hours
Yamamura, K., Aoshima, K., Hiramatsu, S., Hikichi, T., Hiramatsu, S. 1980	lab pink noise	laboratory experiment	To examine the effects of noise of a relatively low peak level to develop damage risk criteria for impulse noise	temporary threshold shift biochemical	13-18	100, 105 dB peak 10, 50, 100 ms. within 20 dB of peak 8 hours
Yamamura, K., Itoh, F. 1981	field experiment traffic noise	descriptive	To investigate the effects of variable noise levels of moderate intensity	temporary threshold shift physiology	6	closed windows: 50 dBA L_{50} open windows: 70 dBA L_{50}
Yamamura, K., Itoh, F., Maehara, N. 1981	lab pink noise	laboratory experiment	To compare changes in TTS and in the circulatory system with exposure to intermittent and steady state noise.	temporary threshold shift physiology	7-9	75, 80, 85 dBA peak 500 ms, 1 sec. rise time 6, 10 sec. cycle 9.25 hours

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
incidence of: - zero response - transitory response - change of stage - awakening - positive response	regression		For same Leq, three times as many disturbances due to road noise, but also three times as many noise occurrences.	Noise: 6 Health: 8 Design and Analysis: 4 1/2
incidence of: - use of drugs or medication - use of psycho-tropic drugs - visit to GP - out-patient clinic - in-patient - use of community health and welfare services	χ^2	self-selection	- no clear trend across noise for any of the 6 indicators	Noise: 4 Health: 5 1/2 Design and Analysis: 10
height, weight, blood pressure and 25 biological tests - incidence of abnormal values	χ^2	- other sources of hearing loss - controlled for age - socio-economic factors	- no significant difference in incidence of abnormal values between hearing loss and no hearing loss groups - in age group 50-59 years, hearing loss associated with high cholesterol values	Noise: 3 Health: 8 Design and Analysis: 7 1/2
- temporary threshold shift - urinary 17 OHCS patterns over time	regression		- urinary 17 OHCS only significant for 80 dB, 1 and 2 min. periods - TTS growth significant for steady state and short periods - length of exposure important	Noise: 5 Health: 7 Design and Analysis: 5
- TTS growth over time - urinary 17 OHCS levels over time	regression		- TTS growth less for impulse noise than for equal energy steady state noise - TTS significantly related to duration, repetition rate - urinary 17 OHCS production lower in impulse noise than steady state noise	Noise: 5 1/2 Health: 7 Design and Analysis: 5
- TTS growth over time - blood pressure over time	regression	- rising temperature with length of exposure	- TTS increased slightly with noise exposure - some subjects showed a rise in blood pressure	Noise: 6 Health: 7 Design and Analysis: 3 1/2
TTS, blood pressure, heart rate, electrocardiogram, over time	regression		- no significant differences in blood pressure and heart rate between conditions - conventional rules for evaluation of intermittent noise do not hold for TTS	Noise: 5 Health: 7 Design and Analysis: 4

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Zentall, S.S., Shaw, J.H. 1980	lab recorded classroom noise	laboratory experiment	"To assess the effects of classroom noise on the activity and performance of hyperactive and comparison children."	task performance	I 24 hyperactive 24 control II 20 hyperactive 20 contro	I quiet 64 dB noisy 69 dB II quiet 52-60 noisy 70-72 25 minutes

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
I number of correct answers to math problems II errors of omission and comission on a cancellation task	analysis of covariance		- control children performed better in high noise - hyperactive children performed worse in high noise (not significantly) "High levels of classroom noise appear to exacerbate those problem areas outstanding in hyperactive children relative to control children."	Noise: 6 Health: 7 Design and Analysis: 9

Infrasound

Author	Research Setting	Study Type	Problem Statement	Outcome	Sample	Noise Measure
Evans, M.J., Tempest, W. 1972	lab pure tone	laboratory experiment	"...to see if infrasound, at the levels measured in vehicles has any effect on the sense of balance and psychological fitness of normal human observers."	balance and psychological awareness	25	110-146 dB 2-20 Hz 60 sec
Green, J.E. Dunn, F. 1968	naturally occurring infrasound Illinois	descriptive	To see if distantly produced infrasonic waves (from weather systems) affected selected aspects of human behaviour	human behaviour	1000 accident claims 1500 students	75-95 dB theorized
Harris, C.S., Johnson, D.L. 1978	lab infrasound & ambient or background noise	laboratory experiment	To assess the effects of infrasound on cognitive behaviour	task performance	I 12 II 12 III 16	125, 132, 142 dB infrasound at 7 Hz 65 dB ambient 110 dB low frequency background I 15 min. II 30 min. III 15 min.
Jerger, J., Alford, B., Coats, A. 1966	lab infrasound	laboratory experiment	"...to explore the frequency region from 2 to 22 cps in an attempt to determine critical sound pressure levels leading to temporary threshold shift."	temporary threshold shift	19	119-144 dB 2-22 Hz 3 min.
Kyriakides, K., Leventhall, H.G. 1977	lab whole-body exposure to infrasound	laboratory experiment	"To assess the degree to which the performance of a number of tasks can be maintained or changed by exposure to infrasound.	task performance	I 6 II 26	115 dB 2-15 Hz 36 min. control-70 dBA background
Mohr, G.C., Cole, J.N., Guild, E., von Gierke, H.E. 1965	lab low frequency and infrasound whole-body exposures	laboratory experiment	to investigate human tolerance to high intensity, low frequency noise.	- auditory - physiology - voluntary tolerance	5	up to 154 dB 1-100 Hz 2 min.
Slarve, R.N., Johnson, D.L. 1975	lab whole-body exposure	laboratory experiment	"...to verify that the levels produced were safe for at least an 8-min. exposure."	physiological psychological	4	up to 144 dB 1-20 Hz 8 min.

Outcome Measurement	Analysis and Statistics	Possible bias and Confounders	Conclusions	Evaluation
- involuntary eye movement - nystagmus - reaction time and visual acuity in a shape recognition task	none	random eye movements	- no effect on visual disturbance - some effect on reaction time (no gradient) - nystagmus evident; most pronounced at 7 Hz "... infrasonic noise has a significance in both comfort and safety in transportation..."	Noise: 4 Health: 4 Design and Analysis: 1
incidence of - automobile accidents - school absenteeism	correlations	many possible e.g. effect of local weather conditions itself on parameters	- increases in times of intense disturbance "a correlation may exist"	Noise: 2 Health: 5 Design and Analysis: 3
I. no of searches completed in serial search task II and III. % correct in complex counting task	analysis of variance		- no significant effects found "Very high levels of infrasound, more than 150 dB, may be necessary to produce decrements in cognitive performance."	Noise: 5 Health: 6 Design and Analysis: 7
noise level required to produce 10 dB threshold shift, that persisted 3 minutes after exposure	descriptive		- no clear-cut functional relationship between TTS and exposure signal - all TTS produced by exposure to 137-141 dB. - frequencies affected by TTS were from 3 to 8 KHz.	Noise: 4 Health: 7 Design and Analysis: 3
scores in central and peripheral tasks in following a moving pointer and responding to lights	- analysis of variance - Wilcoxon		- no significant decrements in task performance - degradation of performance over time - changes in performance over time different than for audible noise.	Noise: 5 Health: 5 Design and Analysis: 5
- auditory acuity - voluntary tolerance subjective & objective: - visual acuity - spatial orientation - speech intelligibility - EKG - fine finger dexterity	not specified	- used only noise - experienced personnel - sound above 100 Hz - wore hearing protectors	- no significant objective changes - many severe subjective complaints - did not reach the voluntary tolerance limit.	Noise: 4 Health: 5 Design and Analysis: 1
- examination of tympanic membrane - audiogram - subjective: - vibration - respiration - psychological	not specified		- "no objective evidence (including audiograms) of any detrimental effect due to infrasound." - pressure build-up in middle ear, voice modulation, body vibration occurred consistently.	Noise: 4 Health: 5 Design and Analysis: 3