

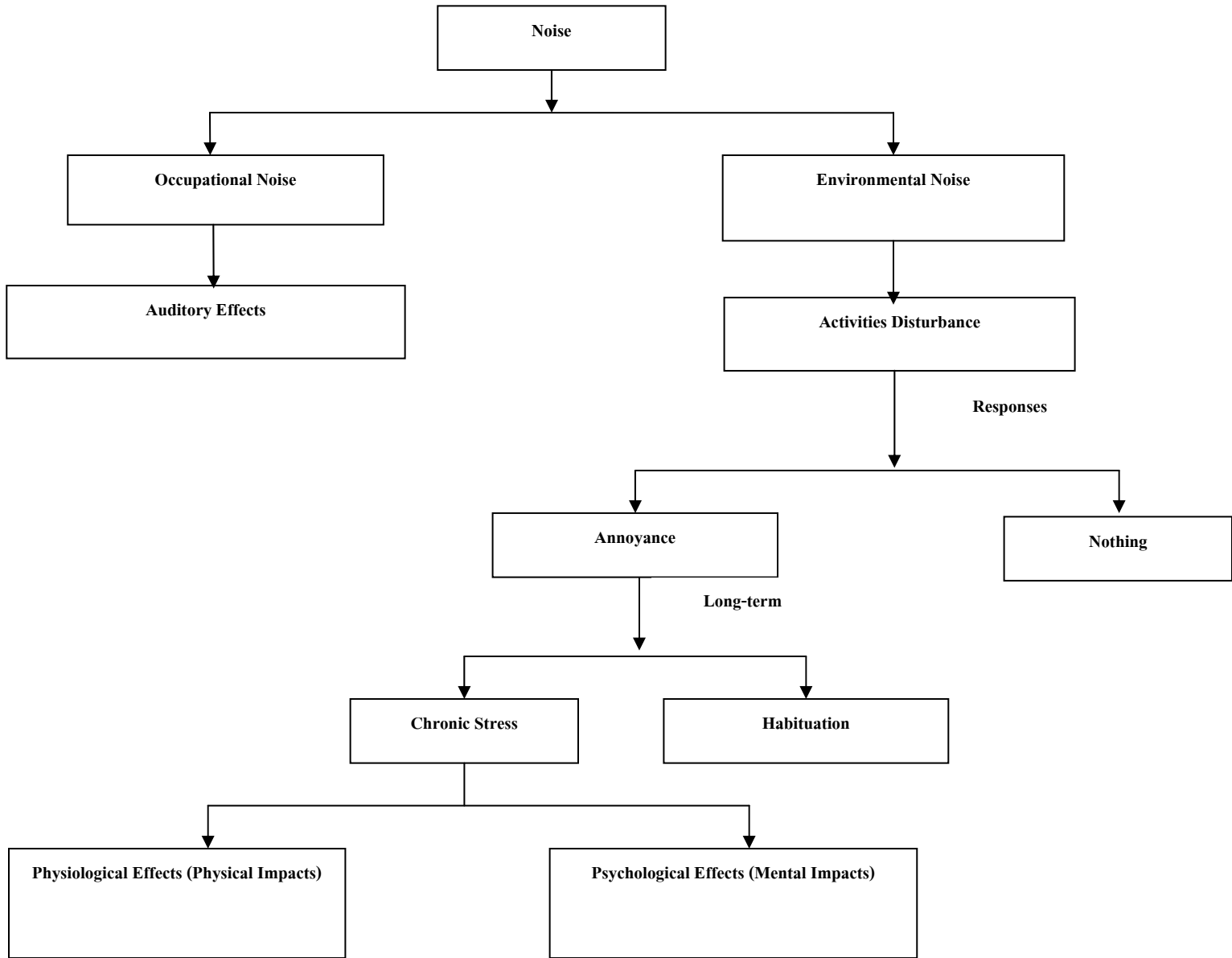
HEALTH AND WELL-BEING IMPACTS BY AIRCRAFT NOISE: a cross-sectional study

Presentation Prepared for
ITLS Seminar, University of Sydney
11 April 2006

by

THARIT ISSARAYANGYUN

University of New South Wales
AUSTRALIA



High Blood Pressure?

- High blood pressure (or hypertension) is elevated pressure of the blood in the arteries. Two main factors cause hypertension: (1) the heart pumps blood with excessive force; and (2) the arterioles narrow resulting blood flow exerts more pressure against the vessels' walls.
- The World Health Organisation defined **systolic blood pressure over 160 mmHg** or **diastolic blood pressure over 90 mmHg** as a threshold of high blood pressure.
- Hypertension is mainly categorised into two: (1) *Primary Hypertension*; and (2) *Secondary Hypertension*.
- The causes of *Primary Hypertension* are unknown but are certainly based on complex processes in all major organs and systems, including the heart, blood vessels, nerves hormones, and the kidneys.
- The main causes of *Secondary Hypertension* are medical conditions (such as kidney disease particularly in older people, sleep apnea or temporary cessation of breathing during sleep, and pregnancy), medications (such as corticosteroids, long-term use of nonsteroidal anti-inflammatory drugs, cold medicines containing pseudoephedrine, and oral contraceptives), alcohol, coffee, cigarettes, and emotional factors (such as mental stress, anxiety, and depression).

HEALTH ?

“Health is not only the absence of disease but also including a state of complete in physical, mental, and social well-being” (WHO, 1995)

Health Related Quality of Life?

Health related quality of life is a subjective health assessment.

Patrick and Erickson (1993) defined health related quality of life as “the value assigned to duration of life as modified by the impairments, functional states, perceptions, and social opportunities that are influenced by disease, injury, treatment, or policy.”

Research Problems

- The deficiency in the interpretation of the meaning of 'health' as just the absence of disease.
- The lack of comprehensive epidemiological study of health related quality of life impacts by aircraft noise and study of association between high blood pressure and aircraft noise with emotional stress as a mediating factor.

Research Objectives

To Explore two core research questions:

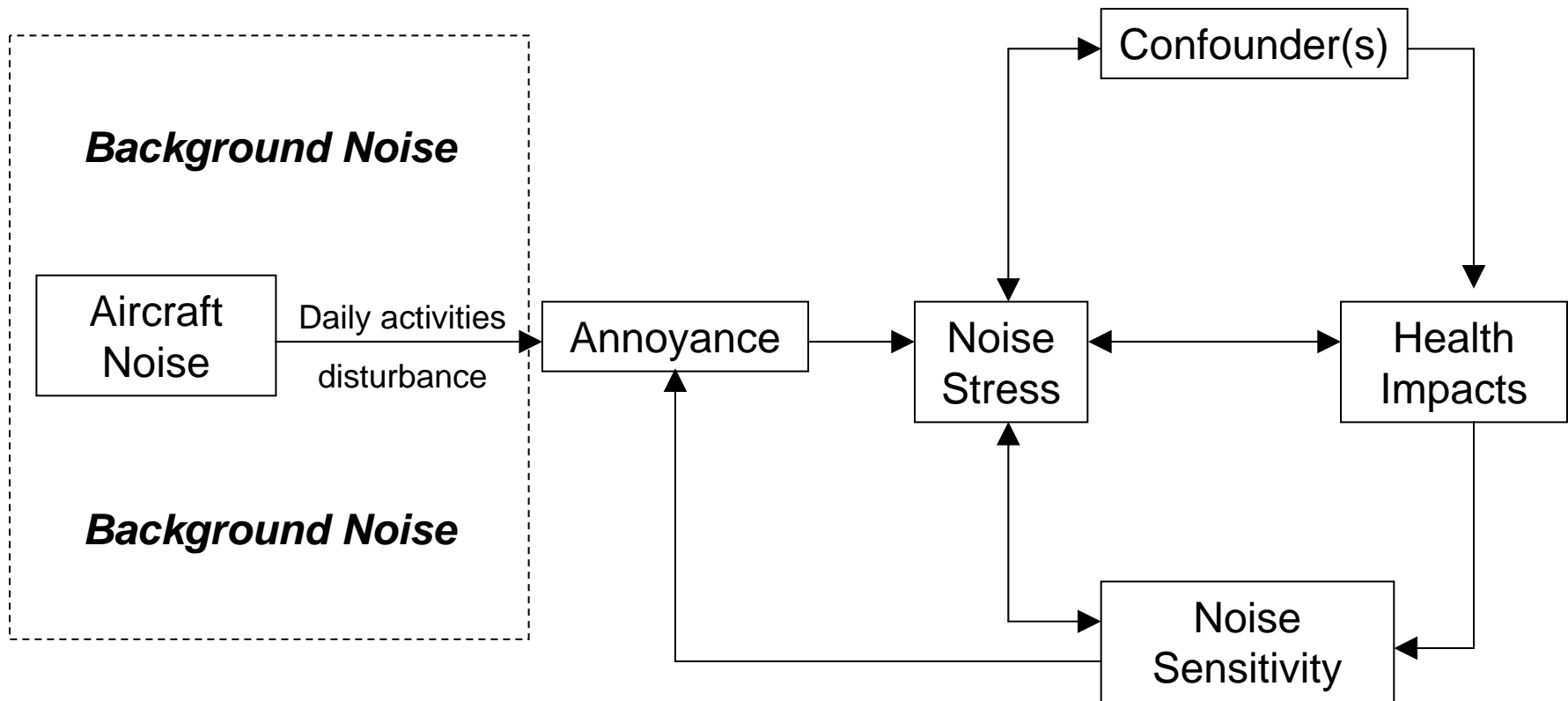
“Is health related quality of life worse in community chronically exposed to aircraft noise than in community not exposed?”

“Does long-term aircraft noise exposure associate with adult high blood pressure level via noise stress as a mediating factor?”

Scope of Research

1. The research focused on noise generated from aircraft taking off and landing.
2. The impact of aircraft noise on human health was limited to non-auditory effects.
3. The study samples were located on local traffic roads in metropolitan Sydney. Effects from major non-aviation noise sources, such as, highway noise, railway noise, industrial noise were excluded.

Research Assumptions



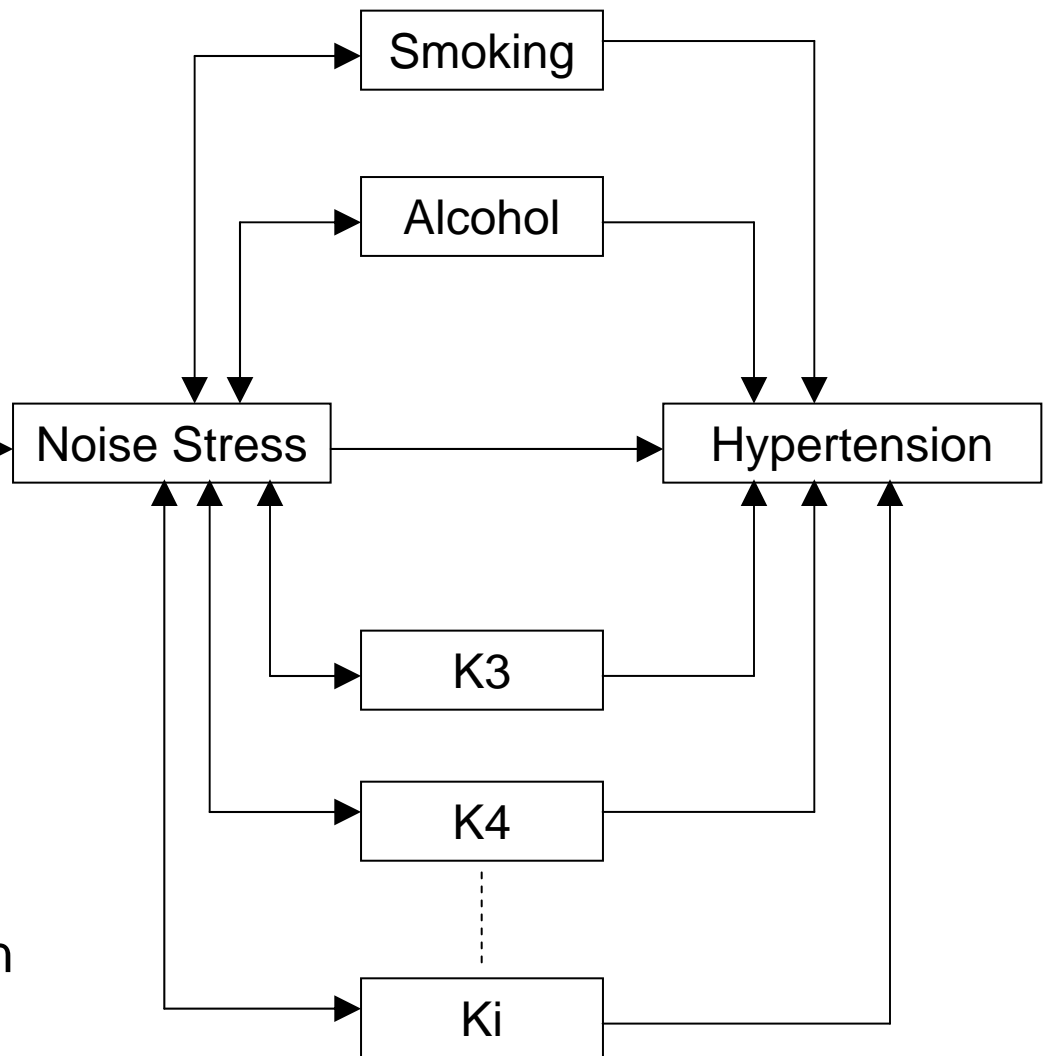
Confounding Factors

- 1) To be a known risk factor of the interested disease.



- 2) To be a factor associated with exposure but not a result of exposure.

- 3) To be a factor that is not an intermediate variable between exposure and disease.



Research Methodologies

1. Problem identification.
2. Assemble a group (or network) of researchers with the necessary skills to offer a perspective on the problem.
3. Review existing knowledge on the problem area to exhaust all disciplinary and interdisciplinary conceptualisations and explanations of the problem.
4. Design research enquiry from research gaps identified in (3).
5. Implement a pilot study and a main social survey
6. Undertaking an extensive acoustic measurement program to measure aircraft noise and background environmental noise.
7. Analysing health and well-being data by using a suitable multivariate statistical technique.

A Case Study

SYDNEY AIRPORT



Questionnaire

- Health Related Quality of Life (SF-36)
- Prevalence of Hypertension
- Noise Stress
- Noise Sensitivity
- Noise Annoyance
- Confounding Factors
- Demographic Characteristics



What do SF-36 scales mean?

	Definition	
	Lowest Possible Score	Highest Possible Score
Physical Functioning (PF)	Very limited in performing all physical activities, including bathing or dressing	Performs all types of physical activities including the most vigorous without limitations due to health
General Health (GH)	Evaluates personal health as poor and believes it is likely to get worse	Evaluates personal health as excellent
Vitality (VT)	Feels tired and worn out all of the time	Feels full of pep and energy all of the time
Mental Health (MH)	Feelings of nervousness and depression all of the time	Feels peaceful, happy, and calm all of the time

“The greater score means the better health condition”

Pilot Study

Objective: To test the performance and increase both reliability and validity of the proposed health survey instruments

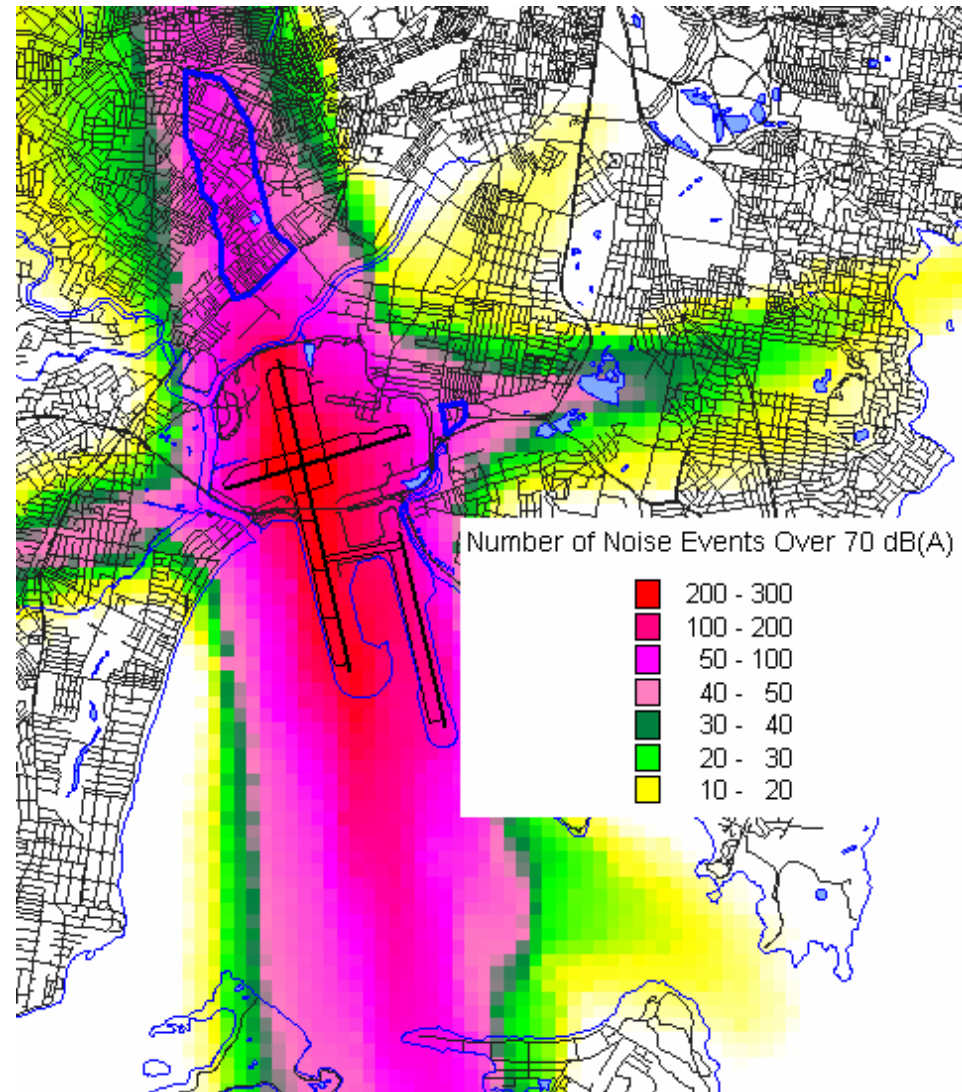
Location: Suburb of Kurnell

Period: May – July 2003

Sample size: 100 subjects

Valid response rate: 52%

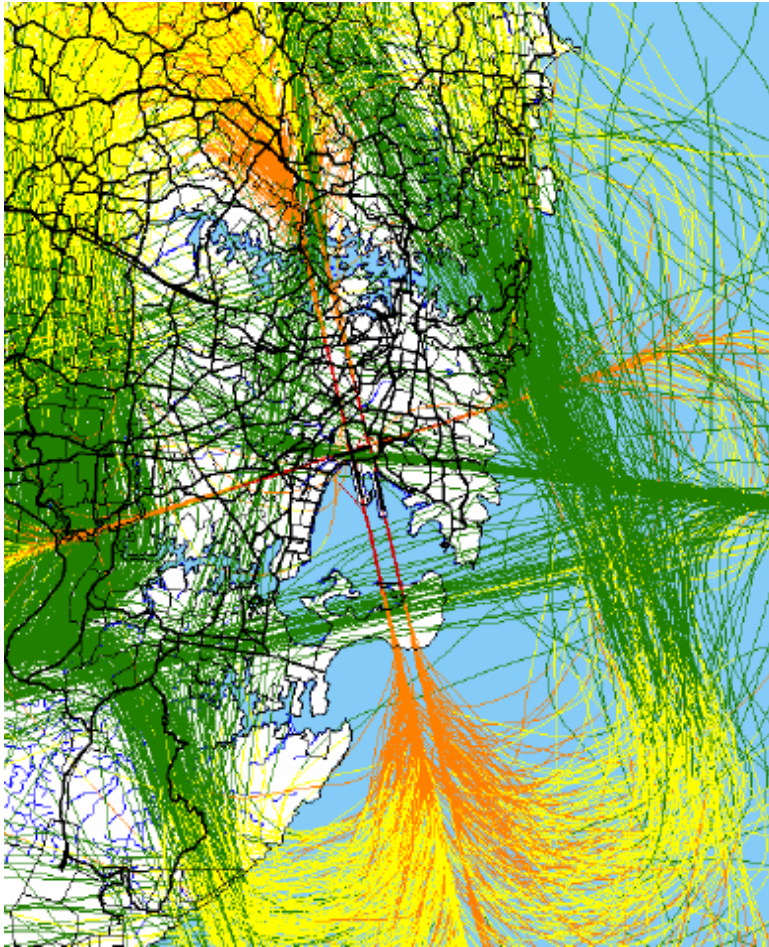
Aircraft Noise Exposure Area



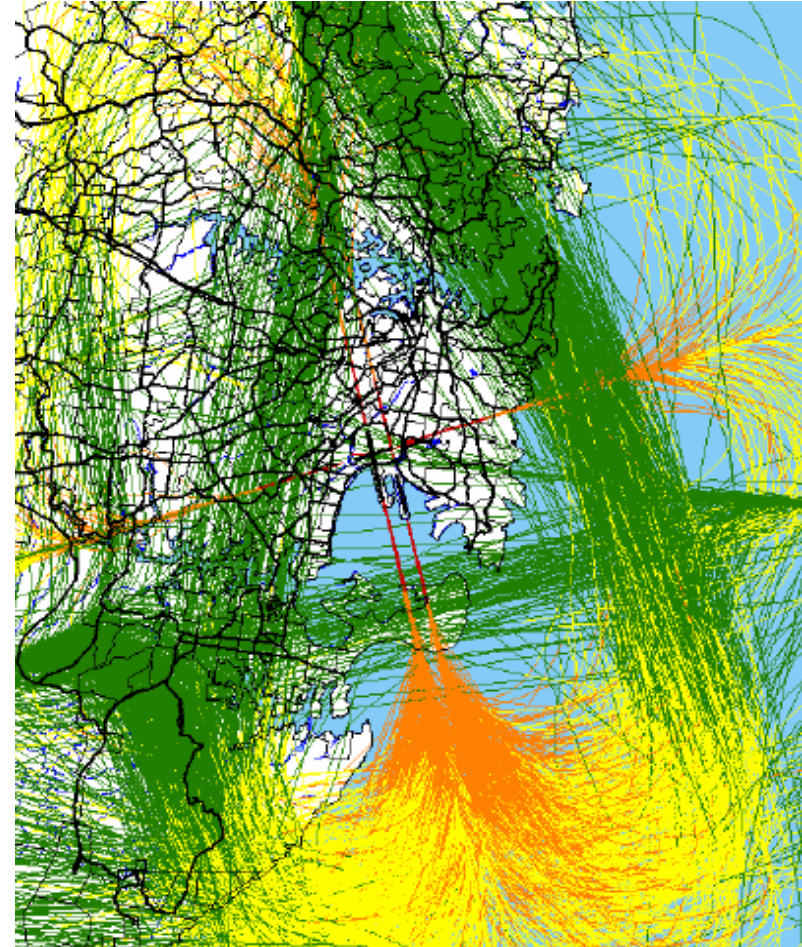
Criteria for Selection of Control Area

- Free from aircraft noise exposure
- Similar socio-economic status with aircraft noise exposure group

Comparison of Sydney Airport's Track Plots Coloured by Height for Jet Arrivals



2-8 December 2003



2-8 June 2004

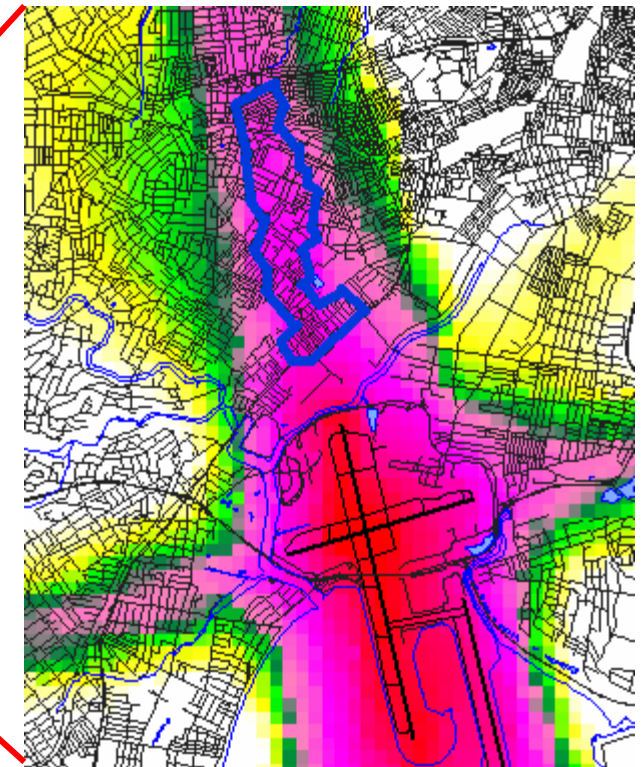
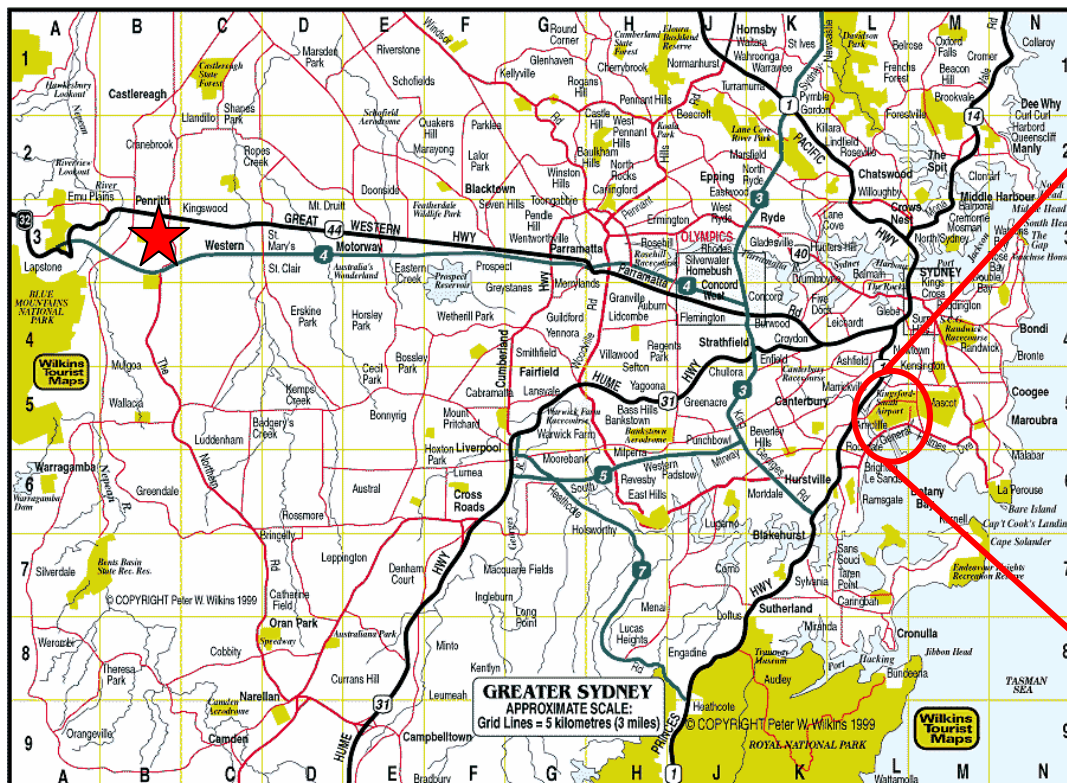
Mann-Whitney Test of the Comparison of 2001 SEIFA Indices between Exposure Area and Control Areas

Mann-Whitney Test	Number of CD	Disadvantages		Advantage and Disadvantage		Economic and Resource		Education and Occupation	
		Z	Sig.(2-tailed)	Z	Sig.(2-tailed)	Z	Sig.(2-tailed)	Z	Sig.(2-tailed)
Exposure Group	30								
Option A	13	-5.157	0.000	-5.157	0.000	-5.157	0.000	-5.157	0.000
Option B	18	-0.809	0.418	-3.024	0.002	-2.641	0.008	-4.685	0.000
Option C	17	-4.627	0.000	-5.491	0.000	-5.535	0.000	-5.602	0.000
Option D	15	-3.275	0.001	-5.128	0.000	-5.153	0.000	-5.345	0.000

- Exposure: Sydenham, Tempe, St. Peters, Marrickville, Stanmore, Petersham
- Option A: Ashcroft, Heckenberg, Sadleir
- Option B: South Penrith
- Option C: Dharruk, Hebersham, Blackett
- Option D: Colyton, Oxley Park

Study Population

- Control Group
 - South Penrith (approx 55km west from Sydney Airport)
- Noise Exposure Group
 - Sydenham, Tempe
 - St Peters, Marrickville
 - Stanmore, Petersham



Criteria for selection of study sample

- Every home address (excluding apartments, commercial buildings, addresses for sale or lease, and abandoned addresses) located in the local traffic areas where major non-aviation noise sources, such as, highway noise, railway noise, industrial noise, are insignificant) in the study population were included;
- Study sample was randomly chosen by a computer to ensure an equal chance of selection.
- Study sample has lived in their existing house for at least 1 year.

Required Sample Size

Required sample size = $(\mathbf{N} \times \mathbf{D})/\mathbf{E}$

where:

N is a number of study group (exposure group and control group)

D is a sample size needed to detect 5 point difference between two non-experimental groups (two-tailed t-test, power = 80%) (SF36, 1996)

E is an expected response rate (52%) determined from the pilot study

Therefore,

$$\begin{aligned}\text{Required sample size} &= (2 \times 274) / 52\% \\ &= 1,054 \text{ subjects}\end{aligned}$$

Sample size for the main health survey is 1,500 subjects (or 750 subjects per group)

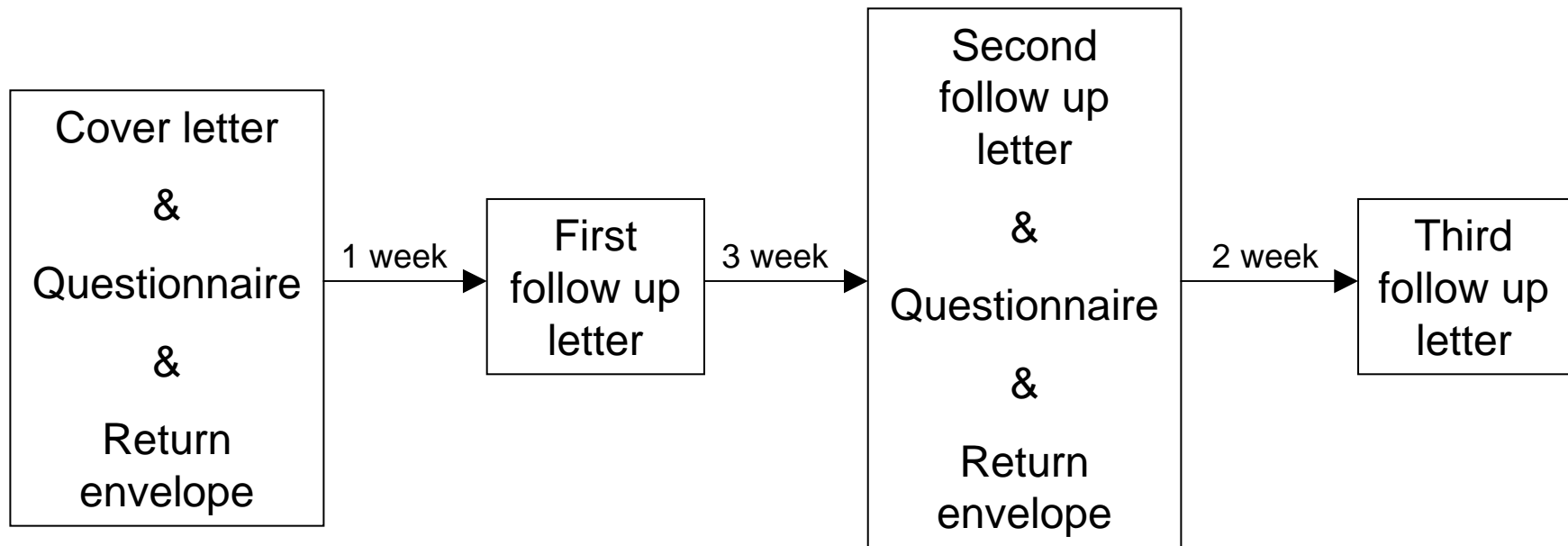
Translation of Health Survey Instruments

[by the Multicultural Unit, Prince of Wales Hospital]

	Total People	English Only (number of people) (percent)	Other Language (number of people) (percent)		
			First	Second	Third
Noise Exposure Group	14,333	8,016 55.9%	Greek 1,001 7.0%	Vietnamese 747 5.2%	Arabic 625 4.4%
Control Group	12,049	10,587 87.9%	Arabic 129 1.1%	Greek 86 0.7%	Italian 82 0.7%

Source: 2001 Census of Population and Housing, ABS

Postal Self-Administrative Technique



Main Survey: April – June 2004



Sample Size & Response Rate

		Exposure	Non-Exposure	Total	%
Return	Response	372	332	704	47%
	Refuse	36	56	92	6%
Not Return		342	362	704	47%
Total		750	750	1500	100%

Demographic Characteristics and Socioeconomic Status by Study Groups

Variable	Noise Exposure Group	Control Group	<i>p-value</i>
Mean age (year)	46.63 (SD=15.57)	50.85 (SD=15.22)	0.001
Sex (% female)	190 (57%)	209 (67%)	0.009
Education			
Bachelor degree or higher	118 (35%)	37 (12%)	<0.001
Certificate / Diploma	106 (32%)	144 (46%)	
High school or lower	108 (33%)	131 (42%)	
Employment status			
White collar	167 (51%)	118 (38%)	0.003
Blue collar	50 (15%)	64 (20%)	
Unemployed	19 (6%)	13 (4%)	
Not in labour force	94 (28%)	119 (38%)	
Household weekly income			
over AUD\$2,000	33 (10%)	22 (7%)	0.451
AUD\$401 - AUD\$1,999	225 (69%)	214 (71%)	
under AUD\$400	68 (21%)	66 (22%)	
Smoking status			
Current smoker	76 (24%)	44 (14%)	0.014
Ex-smoker	98 (30%)	108 (36%)	
Never smoke	149 (46%)	153 (50%)	
Alcohol consumption			
High	54 (18%)	43 (15%)	0.623
Low	186 (60%)	183 (62%)	
None	68 (22%)	68 (23%)	
Nutrition			
Salty food	68 (20%)	51 (17%)	0.202
No salty food	265 (80%)	258 (83%)	
Exercise activity level			
High exercise	59 (18%)	40 (13%)	0.034
Moderate exercise	77 (23%)	66 (21%)	
Low exercise	134 (41%)	122 (39%)	
Sedentary	58 (18%)	82 (27%)	
Body Mass Index			
Obesity	55 (17%)	81 (29%)	0.006
Overweight	104 (33%)	90 (32%)	
Acceptable weight	132 (42%)	91 (33%)	
Underweight	25 (8%)	18 (6%)	
Marital status			
Married/De facto	186 (56%)	219 (70%)	<0.001
Widowed / Divorced / Separated	55 (16%)	64 (21%)	
Never married	93 (28%)	29 (9%)	
Acoustic Insulation			
Yes	126 (39%)	9 (3%)	<0.001
None	198 (61%)	286 (97%)	

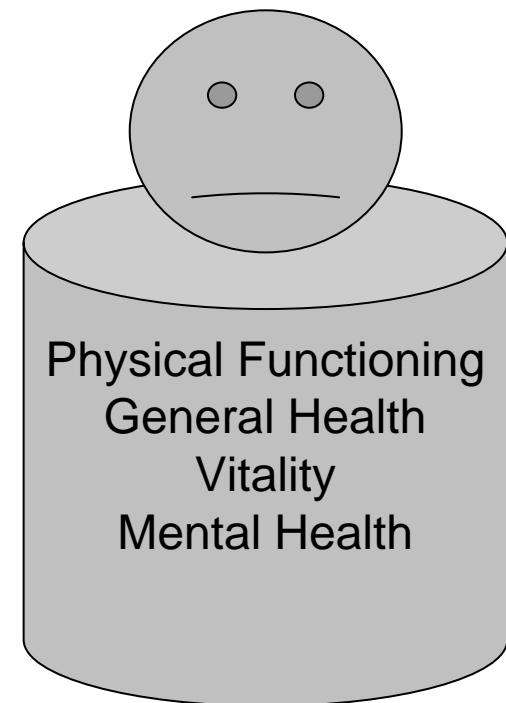
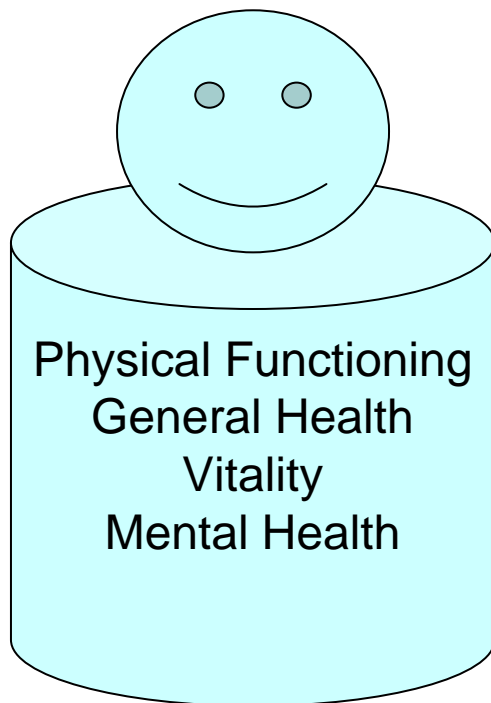
Descriptive Statistics of Health and Related Measures

Variable	Noise Exposure Group	Control Group	<i>p-value</i>
Mean Physical Functioning Score	79.09	79.23	0.941
Mean General Health Score	64.49	66.08	0.370
Mean Vitality Score	54.58	57.02	0.128
Mean Mental Health Score	68.02	73.53	<0.001
Hypertension	51 (15.0%)	55 (17.4%)	0.450
Hypertension in Parent(s)	154 (45.4%)	132 (41.8%)	0.297
High Cholesterol Level	62 (18.3%)	47 (14.9%)	0.215
Mean Noise Stress Score	6.44 (SD=2.31)	4.25 (SD=1.93)	<0.001
Mean Noise Sensitivity Score	27.76 (SD=7.92)	26.97 (SD=7.38)	0.193
Mean Aircraft Noise Annoyance	6.27 (SD=3.04)	1.03 (SD=2.01)	<0.001
Mean Traffic Noise Annoyance	2.61 (SD=2.57)	1.96 (SD=2.31)	0.001

Major Research Question	Number (Kind) of Dependent Variables	Number (Kind) of Independent Variables	Covariates	Analytic Strategy	Goal of Analysis
Significance of group differences	One (continuous)	One (discrete)	None	One-way ANOVA	Determine reliability of mean group differences.
			Some	One-way ANCOVA	
		Multiple (discrete)	None	Factorial ANOVA	
			Some	Factorial ANCOVA	
	Multiple (continuous)	One (discrete)	None	One-way MANOVA	Create a linear combination of DVs to maximize mean group differences.
			Some	One-way MANCOVA	
		Multiple (discrete)	None	Factorial MANOVA	
			Some	Factorial MANCOVA	
	One (continuous)	Multiple (one discrete within <i>S</i>)		Profile analysis of repeated measures	Create linear combination of DVs to maximize mean group differences and differences between levels of within-subjects IVs.
	Multiple (continuous/commensurate)	One (discrete)		Profile analysis	
Multiple (continuous)	Multiple (one discrete within <i>S</i>)		Doubly-multivariate profile analysis		
Prediction of group membership	One (discrete)	Multiple (continuous)	None	One-way discriminant function	Create a linear combination of IVs to maximize group differences.
			Some	Sequential one-way discriminant function	
		Multiple (discrete)		Multway frequency analysis (logit)	Create a log-linear combination of IVs to optimally predict DV.
	Multiple (continuous and/or discrete)	None	None	Logistic regression	Create a linear combination of the log of the odds of being in one groups.
			Some	Sequential logistic regression	
	Multiple (discrete)	Multiple (continuous)	None	Factorial discriminant function	Create a linear combination of IVs to maximize group differences (DVs).
		Some	Sequential factorial discriminant function		

Exploring the First Core Question

[by SPSS v.12]



Analysis of Covariance: Assumptions

(Tabachnick and Fidell, 2001)

- Linearity
- Homogeneity of Regression
- Absence of outliers
- Homogeneity of Variance
- Independence of sample
- Independence of Covariate and Independent Variable
- Normality of dependent variable
- Reliability of Covariates

Comparison of Health Mean Scores

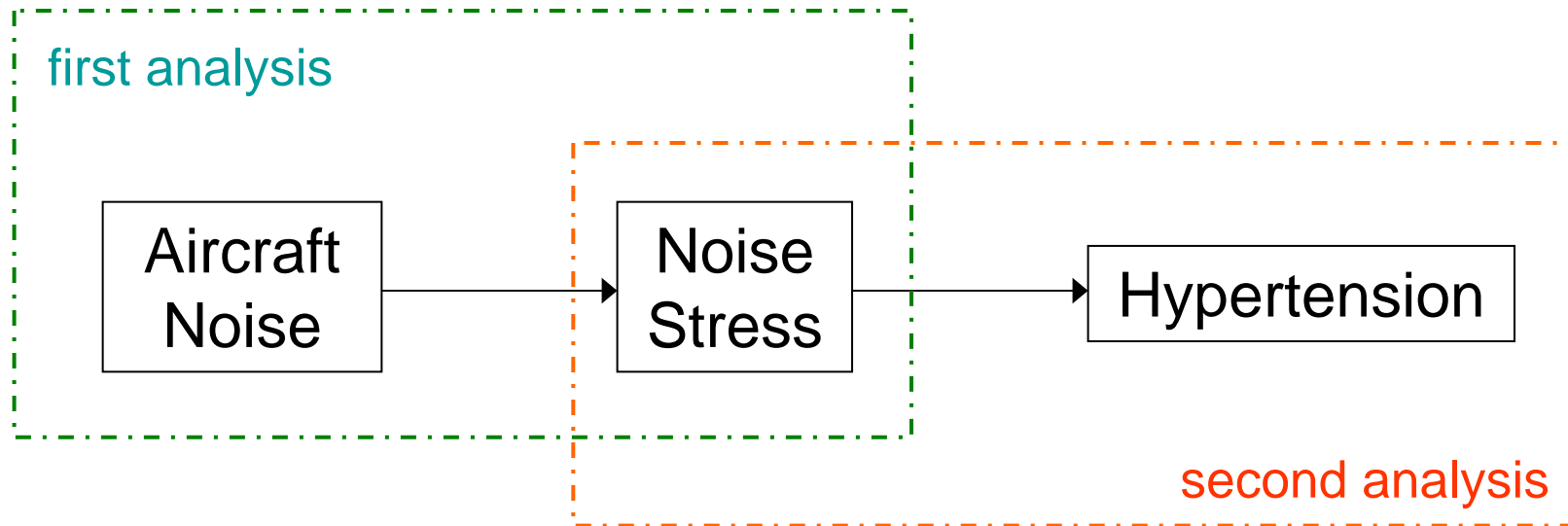
Health Measures	Adjusted Mean Score		df ₁ , df ₂	F ratio	<i>p-value</i>	Covariate	Secondary Independent Variables
	Aircraft Noise Exposure Group	Control Group					
Physical Functioning	83.1	84.9	(1, 573)	5.97	0.015	age	hypertension, body mass index
General Health	60.2	63.4	(1, 615)	6.60	0.010	age	hypertension, exercise activity level
Vitality	54.9	59.9	(1, 589)	6.10	0.014	noise sensitivity	employment status, exercise activity level
Mental Health	67.4	71.4	(1, 537)	15.19	<0.001	noise sensitivity	exercise activity level, smoking status, highest education level

Interpretation

- After controlling for age, prevalence of hypertension, and body mass index, health related quality of life in term of **Physical Functioning** of subjects from the aircraft noise exposure area was worse than the control group.
- After controlling for age, prevalence of hypertension, and exercise activity levels, health related quality of life in term of **General Health** of subjects from the aircraft noise exposure area was worse than the control group.
- After controlling for noise sensitivity, employment status, and exercise activity level, health related quality of life in term of **Vitality** of subjects from the aircraft noise exposure area was worse than the control group.
- After controlling noise sensitivity, exercise activity levels, smoking status, and highest education level, health related quality of life in term of **Mental Health** of subjects from the aircraft noise exposure area was worse than the control group.

Exploring the Second Core Question

[by SPSS v.12]



Logistic Regression: Variable Selection Strategy

(Hosmer and Lemeshow, 2000, pp.91-116)

1. Univariable analysis of each variable – any variable whose univariable test has a $p\text{-value} \leq 0.25$ is a candidate for the multivariable model along with all variables of known clinical importance and the set up exposure variable.
2. Multivariate analysis – any variable that has non-significance of either $p\text{-value}$ or *Wald statistic* should be discarded.
3. Deleting, refitting and verifying – variable that has not been selected for the original multivariable model may be added and checked by the *Wald statistic* and the *likelihood ratio* test.
4. Linearity test – any continuous variable in the logit is tested for linearity by using two methods: design variables and fractional polynomials. Continuous independent variables that do not satisfy the linearity test should be transformed to the other form of variables such as dichotomous.
5. Interaction test – any interaction will be added to a model if it is statistically significant based on likelihood ratio test and clinical importance.
6. Goodness-of-Fit test – the observed frequencies and the expected frequencies are compared using the *Hosmer-Lemeshow goodness-of-fit statistic*. The good model produces a nonsignificant *chi-square* ($p\text{-value} > 0.05$)

Aircraft Noise & Noise Stress

Variable	Coeff.	Std. Err.	Wald	df	Sig	Odds Ratio	95% CI	
							Lower	Upper
Aircraft noise exposure (yes=1, no=0)	0.958	0.312	9.455	1	0.002	2.61	1.42	4.80
Noise sensitivity score (0 - 45)	0.057	0.017	11.347	1	0.001	1.06	1.02	1.09
Traffic noise annoyance scale (0 - 10)	0.376	0.073	26.537	1	0.000	1.46	1.26	1.68
Aircraft noise annoyance scale higher or equal seven (yes=1, no=0)	2.699	0.408	43.799	1	0.000	14.87	6.69	33.08
Traffic noise annoyance scale by Aircraft noise annoyance scale higher or equal seven	-0.257	0.092	7.757	1	0.005	0.77	0.65	0.93
Constant	-5.062	0.583	75.423	1	0.000	0.01		

Logistic Function, $P(X) = 1/(1+e^{-X})$

Logit Model,

$$X = (-5.062) + (0.958)(\text{aircraft noise exposure}) + (0.057)(\text{noise sensitivity}) + (0.376)(\text{traffic noise annoyance}) + (2.699)(\text{aircraft noise annoyance}) + (-0.257)(\text{traffic noise annoyance})(\text{aircraft noise annoyance})$$

Hosmer and Lemeshow Test for the First Analysis

Decile of Risk	Noise stress = no		Noise stress = yes		Total
	Observed	Expected	Observed	Expected	
1	63	63	1	1	64
2	58	59	3	2	61
3	60	60	3	3	63
4	61	59	2	4	63
5	59	58	4	5	63
6	53	53	10	10	63
7	42	43	21	20	63
8	24	27	39	36	63
9	24	20	40	44	64
10	13	14	51	50	64

Chi-square	df	Sig.
3.92	8	0.865

Odd Ratio of the First Analysis

Dependent Variable: Noise Stress

Exposure	Odd Ratio	95% CI	
		lower	upper
Aircraft noise exposure	2.61	1.42	4.80

Noise Stress & Prevalence of Hypertension

Variable	Coeff.	Std. Err.	Wald	df	Sig	Odds Ratio	95% CL	
							Lower	Upper
Noise stress (yes=1, no=0)	1.008	0.290	12.12	1	0.000	2.74	1.55	4.84
Aircraft noise exposure (yes = 1, no = 0)	-0.484	0.276	3.08	1	0.079	0.62	0.36	1.06
Cholesterol level (high=1, low=0)	1.350	0.262	26.56	1	0.000	3.86	2.31	6.45
Age	0.067	0.009	51.62	1	0.000	1.07	1.05	1.09
History of parent hypertension (yes = 1, no = 0)	0.530	0.258	4.23	1	0.040	1.70	1.03	2.82
Constant	-5.906	0.623	89.92	1	0.000	0.00		

Logistic Function, $P(X) = 1/(1+e^{-X})$

Logit Model,

$X = -5.906 + (1.008)(\text{noise stress}) + (-0.484)(\text{aircraft noise exposure}) + (1.350)(\text{cholesterol}) + (0.067)(\text{age}) + (0.530)(\text{history of hypertension in parent})$

Hosmer and Lemeshow Test for the Second Analysis

Decile of Risk	hypertension = no		hypertension = yes		Total
	Observed	Expected	Observed	Expected	
1	64	63	0	1	64
2	63	62	1	2	64
3	63	61	1	3	64
4	60	59	3	4	63
5	56	59	8	5	64
6	56	57	8	7	64
7	52	54	12	10	64
8	48	49	16	15	64
9	44	42	20	22	64
10	28	27	36	37	64

Chi-square	df	Sig.
5.082	8	0.749

Odd Ratio of the Second Analysis

Dependent Variable: Prevalence of Hypertension

Exposure	Odd Ratio	95% CI	
		lower	upper
Noise Stress	2.74	1.55	4.84

Interpretation

- After controlling for noise sensitivity, traffic noise annoyance, aircraft noise annoyance, and interaction between traffic noise annoyance and aircraft noise annoyance, subjects from the aircraft noise exposure area have the *odds* of 2.61 of having noise stress compared with subjects from the control area.
- After controlling for aircraft noise exposure, cholesterol level, age, and history of hypertension in parent(s), subjects who have been suffering from noise stress have the *odds* of 2.74 of having hypertension compared with subjects without noise stress.

Conclusion

- “Health related quality of life, in term of physical functioning, general health, vitality, and mental health, of community chronically exposed to high aircraft noise level were worse than the control area”.
- “Subjects (aged 15 – 87) who have been chronically exposed to high aircraft noise level have the odds of 2.61 of having chronic noise stress. In addition, person suffered from noise stress has the odds of 2.74 of having hypertension compared with those without chronic noise stress”