AIRCRAFT NOISE AND CHILD BLOOD PRESSURE

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I. NOTE ON THE AUTHOR’S CONTRIBUTION

The Inner Sydney Child Blood Pressure Study was part of a suite of studies commissioned and funded by the Federal Airports Corporation to examine aspects of the health effects of domestic aircraft noise exposure. The role of the author in the Inner Sydney Child Blood Pressure Study was in the design of the study itself, in supervision of child BP data collection, both at baseline and follow-up, and in the processing and statistical and epidemiological analyses of the BP, survey and noise and physical measurement data. The author was also responsible for the design of the survey instrument and the measurement protocols used.

Overall supervision of the project was by a steering committee consisting of members making up the Inner Sydney Child Blood Pressure Study group, including Associate Richard Taylor (School of Public Health, University of Sydney), Dr Norman Carter and Mr Peter Peploe (both of the National Acoustic Laboratories), Dr Soames Job, Department of Psychology, University of Sydney, and the author. Project supervision included liaising with the various school authorities and with the individual school principals in the recruitment of subjects to the study; the training and supervision of fieldworkers; assessment of data quality and its analysis; and the writing of reports for the funding body. Three major and two interim reports were prepared for the funding body relating to this study, co-authored by the study group members. These were:


Aircraft noise exposure data were collected and processed by Peter Peploe of the National Acoustic Laboratories, both at baseline and follow-up. Geocoding of school and home addresses and aircraft noise exposure data at study baseline was carried out by a research assistant (Layton Walton); geocoding of follow-up addresses and noise data was carried out by the author. The author also supervised a dietary salt study of a baseline subsample, with use of a standard food frequency questionnaire, and co-supervised the subsequent analysis and writing up of these data in 1997, as a treatise by a Master of Public Health candidate in the School of Public Health, University of Sydney.

Parts of the literature review, have been published previously in a peer-reviewed journal and were co-authored by Associate Professor Richard Taylor and Professor David Lyle:


This publication has been included in Appendix 3.

The remaining work, including the formulation of specific hypotheses for testing within a coherent theoretical paradigm, the interpretation of the results, and the writing up and presentation of this thesis is that of the author.
II. INSTITUTIONAL HUMAN ETHICS COMMITTEE APPROVALS AND CONSENT

Ethics committee approvals were obtained from both the Sydney University Human Ethics Committee and the Central Sydney Area Health Service Ethics Committee to conduct this study. Permission was obtained from the NSW Department of Schools Education and the Catholic Schools Commission to survey and measure primary schoolchildren from schools proximate to the existing and projected flight paths of Sydney airport. Schools unaffected by aircraft noise were also approved for inclusion in the study in order to provide a suitable control comparison group (unexposed to aircraft noise). Permission was sought from each school principal of the individual schools to take part in the study. Also included at this level were independent schools not subject to the central State or Catholic education authorities.

Finally, individual consent was sought from the parents of the children. Consent was active -- that is, only those children whose parents had signed and returned the consent form to the school were measured.
III. ACKNOWLEDGMENTS

First I would like to acknowledge the Federal Airports Corporation (FAC), as it was known at the time, for funding both the baseline and follow-up phases of this study. Thanks in particular are due to Heloise Campbell who was the main liaison person at the FAC.

The most important component of any research project involving empirical measurement of study and outcome factors is the personnel responsible for the collection of the data. In this regard, I unreservedly acknowledge the contributions of the blood pressure measuring teams who comprised:

**Baseline BP measurement team:** Sara-Jane Bush, Gladys Hitchin, Amelia Howland, Denise Lawson, Yvette Lawson and Patrick Parlow.

Special thanks are due to Patrick Parlow for his efforts in liaising with school principals in ensuring the maximum response to the survey; and to Gladys Hitchin whose eye for detail, persistence and organisational aptitude ensured that the child BP data were collected in an orderly manner and entered into computer format accurately.

**Follow-up BP measurement team:** Gladys Hitchin, Estella Ortiz, Pam Richardson and Alice Uribe.

Special thanks again are due to Gladys Hitchin who was untiring in her efforts in liaising with school principals, and in collecting and entering the follow-up BP data into computer format. I thank Gladys also for training the follow-up BP measurement team.

I thank Peter Peploe from the National Acoustic Laboratories for his input and expertise in the devising of a system for measuring aircraft noise exposures and converting these raw data into the noise metric used in this study. This was an involved and arduous task requiring a rare and innovative talent and expertise in sound and noise measurement and analysis that has contributed to the cutting-edge rigour of the exposure measures used in this thesis.

I acknowledge the input of Layton Walton who was responsible for geocoding baseline
school and home address information along with baseline noise data into a geographic information system data base which in turn enabled analysis of BP and aircraft noise exposure data.

I thank Dr Norman Carter who headed our study team and provided overall guidance to the project. I thank Norm also for co-supervising this thesis.

I also would like to thank Professor Geoffrey Berry for reading an earlier draft of this thesis to check for statistical and methodological errors.

I especially would like to thank Associate Professor Richard Taylor who is the main supervisor of this thesis and who has been my mentor for the past 12 years. Without Richard’s patient, persistent and good-natured encouragement and sharply insightful critiques this thesis would not have appeared.

I also owe thanks for the moral support given freely by my parents, and by work colleagues, especially Dr KC Tang, Dr Milton Lewis and Professor Charles Kerr.

Finally, I would like to thank my wife, Margaret Penman, who has been more persistent than anyone in ensuring that I completed this thesis. She has made sacrifices above and beyond anything that might be called ‘spousal duty’ and I owe her a debt also beyond ‘spousal duty’.
ABSTRACT

The purpose of the study was to examine the existence of an association between child blood pressure (BP) and exposure to domestic jet aircraft noise in the context of the construction of a new parallel north-south runway at Sydney (Kingsford-Smith) Airport. The baseline study was commissioned and funded by the Federal Airports Corporation (FAC), with measurements conducted in 1994 and 1995. A follow-up longitudinal component to the study was subsequently commissioned and funded by the FAC in 1997, and measurements conducted in the same year. As the same individuals were measured and re-measured over changing conditions of exposure to aircraft noise, the quasi-experimental nature of the study allowed inferences to be made regarding exposure to aircraft noise and child BP.

The main hypotheses for testing were that BP, and within-subject longitudinal changes in BP, are positively related to domestic jet aircraft noise exposure and longitudinal changes in domestic jet aircraft noise exposure respectively. Subsidiary hypotheses tested for evidence of short- and long-term BP adaptation effects where BPs were related to prior changes to aircraft noise exposures.

A sample of 75 primary schools within a 20 km radius of Sydney Airport under various noise exposure conditions, both existing and those projected with the advent of the new runway, participated in the study. The baseline cohort comprised 1,230 Year 3/4 children attending the schools in 1994 and 1995, and the follow-up participants comprised 628 of the original baseline sample re-measured in 1997. Study participants were enrolled by active parental consent. The baseline response rate was approximately 40% of children in the participating schools.

Systolic (SBP) and diastolic (DBP) blood pressure readings of the children were taken using automated BP measuring equipment along with anthropometric measurements (heights, weights, skinfold thicknesses and waist measurements). Parental surveys captured items pertaining to the child’s ethnic background as measured by the country of birth of the child and parent(s), residential address and housing structure, child eating habits and activity levels, along with family and child history of high blood pressure.

Aircraft noise exposure data were collected by the National Acoustic Laboratories and
processed into the energy-averaged noise metric used in Australia for aircraft noise exposure assessment called the Australian Noise Exposure Index (ANEI). Mean exposures for a given calendar month were used in the analysis. ANEI values were geocoded to exact geographic locations using digitised street maps from which values for each house and school address, also geocoded, were interpolated. A child BP measured in a given month was matched to a aircraft noise exposure value both at their school and residential address for that month for analysis.

After adjusting for confounding and other factors, the cross-sectional relationship between BP and aircraft noise exposure was found to be inconsistent. SBP was non-significantly negatively associated with school aircraft noise exposure at baseline (−0.05 mmHg/ANEI, cluster-sampling-adjusted p>0.05), but positively and non-significantly associated with school aircraft noise exposure at follow-up (0.05 mmHg/ANEI, p>0.05). As for SBP, baseline DBP was significantly negatively related to school aircraft noise exposure at (−0.09 mmHg/ANEI, p<0.001) and non-significantly positively associated with school aircraft noise exposure at follow-up (0.05 mmHg/ANEI, p>0.05).

Within-subject BP changes, occurring from baseline to follow-up, regressed on corresponding longitudinal changes in aircraft noise exposures produced inconsistent results. SBP change was positively and non-significantly (0.027 mmHg/ΔANEI, p>0.05) associated with corresponding school aircraft noise exposure change, while SBP change was negatively associated total aircraft noise exposure change (statistically non-significant, −0.06 mmHg/ΔANEI, p>0.05). DBP changes were similarly and non-significantly related to corresponding aircraft noise exposure changes.

Some evidence for short-term BP adaptation to recent changes in aircraft noise exposure was found. Consistent negative associations between systolic and diastolic BP and recent changes in school aircraft noise exposure were found. This association was statistically significant at study baseline (SBP: −0.19 mmHg/ΔANEI, p<0.001; DBP: −0.12 mmHg/ΔANEI, p<0.001), and of similar magnitude although not statistically significant at follow-up (SBP: −0.14 mmHg/ΔANEI; DBP: −0.10 mmHg/ΔANEI, p>0.05). In the presence of inconsistent cross-sectional BP-aircraft noise exposure associations, this finding is consistent with evidence of a homoeostatic BP response to recent changes in aircraft noise exposure, where resting BP returns to pre-existing levels unrelated to aircraft noise exposure. The public health implication of this finding appears to be benign.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAMI</td>
<td>American Association for Advancement of Medical Instrumentation</td>
</tr>
<tr>
<td>ACTH</td>
<td>Adrenocorticotropic Hormone</td>
</tr>
<tr>
<td>ADH</td>
<td>Antidiuretic Hormone</td>
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<tr>
<td>AMP</td>
<td>Adenosine Monophosphate</td>
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<tr>
<td>ANEC</td>
<td>Australian Noise Exposure Concept</td>
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<td>ANEF</td>
<td>Australian Noise Exposure Forecast</td>
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<td>ANEI</td>
<td>Australian Noise Exposure Index</td>
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<tr>
<td>AV</td>
<td>Atrioventricular</td>
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<tr>
<td>BCE</td>
<td>Before the Current Era (a secular version of Before Christ)</td>
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<tr>
<td>BMI</td>
<td>Body Mass Index</td>
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<tr>
<td>BP</td>
<td>Blood Pressure</td>
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<tr>
<td>CAD</td>
<td>Coronary Artery Disease</td>
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<tr>
<td>CHD</td>
<td>Coronary Heart Disease</td>
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<tr>
<td>CVD</td>
<td>Cardiovascular Disease</td>
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<tr>
<td>dB</td>
<td>Decibel</td>
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<tr>
<td>dB(A/B/C)</td>
<td>A, B or C-weighted decibel</td>
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<tr>
<td>DBP</td>
<td>Diastolic Blood Pressure</td>
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<tr>
<td>EIS</td>
<td>Environmental Impact Study</td>
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<tr>
<td>EPNdB</td>
<td>Effective Perceived Noise Decibel</td>
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<tr>
<td>EPNL</td>
<td>Effective Perceived Noise Level</td>
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<tr>
<td>ESB</td>
<td>English Speaking Background</td>
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<tr>
<td>GAS</td>
<td>General Adaptation Syndrome</td>
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<td>GHQ</td>
<td>General Health Questionnaire</td>
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<tr>
<td>INM</td>
<td>Integrated Noise Model</td>
</tr>
<tr>
<td>K4/5</td>
<td>4th/5th Korotkov phase</td>
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<tr>
<td>Ldn</td>
<td>Average sound level with day/night weighting</td>
</tr>
<tr>
<td>LAeq</td>
<td>Equivalent continuous sound pressure level, A-weighted</td>
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<tr>
<td>MAP</td>
<td>Mean Arterial Pressure</td>
</tr>
<tr>
<td>MPP</td>
<td>Multi-centre Postinfarction Program</td>
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<tr>
<td>MRFIT</td>
<td>Multi Risk Factor Intervention Trial</td>
</tr>
<tr>
<td>N70</td>
<td>Mean hourly number of noise events exceeding 70 dB(A)</td>
</tr>
<tr>
<td>NEF</td>
<td>Noise Exposure Forecast</td>
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<tr>
<td>NESB</td>
<td>Non-English Speaking Background</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>NIMBY</td>
<td>Not In My Back Yard</td>
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<tr>
<td>N.I.</td>
<td>Noise Number Index</td>
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<tr>
<td>PNdB</td>
<td>Perceived Noise Decibel</td>
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<tr>
<td>PNL</td>
<td>Perceived Noise Level</td>
</tr>
<tr>
<td>RSNA</td>
<td>Renal Sympathetic Nerve Activity</td>
</tr>
<tr>
<td>SA</td>
<td>Sinoatrial</td>
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<tr>
<td>SBP</td>
<td>Systolic Blood Pressure</td>
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<tr>
<td>SES</td>
<td>Socio-economic Status</td>
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<tr>
<td>SEL</td>
<td>Sound Exposure Level</td>
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<tr>
<td>SPL</td>
<td>Sound Pressure Level</td>
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<tr>
<td>WCGS</td>
<td>Western Collaborative Group Study</td>
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<tr>
<td>WCH</td>
<td>White-coat Hypertension</td>
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