THE UNIVERSITY of ADELAIDE

A Co-Benefit Analysis of Alternative Transportation in Adelaide, Australia:

Integrating Perspectives from Communities and Stakeholders for Sustainable Change

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Discipline of Public Health

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Thesis submitted for the degree of Doctor of Philosophy

May 2015

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2. Ting Xia, Ying Zhang, Pushan Shah, Shona Crabb. Co-benefits of replacing car trips with alternative transportation: A review of evidence and methodological issues, Journal of Environmental and Public Health, P 2013, vol. 2013.

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3. Ting Xia, Pushan Shah, Monika Nitschke, Ying Zhang, Shona Crabb, Evaluating the PM concentration and the health benefits from reducing urban vehicle usage in Adelaide, South Australia: 21st International Clean Air and Environment Conference, 7 – 11 September, 2013, Sydney.

CONFERENCE PRESENTATIONS DURING CANDIDATURE

1. Ting Xia, Ying Zhang, Shona Crabb, Monika Nitschke, Pushan Shah. *Encouraging Alternative Transport Use in Adelaide: Public Perception of Traffic, Environment and Health (Poster).* The 20th IEA World Congress of Epidemiology. Alaska, USA, August 2014

2. Ting Xia, Ying Zhang, Annette Braunack-Mayer, Shona Crabb, Pushan Shah. *Understanding community's perceptions towards active transportation and the policy implications (Invited speaker).*The 5th Asia-Pacific Conference on Public Health, Seoul, Korea, April 2014.

3. Ting Xia, Pushan Shah, Ying Zhang, Shona Crabb. *Evaluating the PM change and health impact due to urban vehicle emissions reduction in Adelaide, South Australia (Oral).* 21st International Clean Air and Environment Conference, Sydney, Australia, September 2013

4. Ting Xia, Ying Zhang, Pushan Shah, Shona Crabb. *Air quality and health Co-Benefits from reduced car travel in Adelaide, South Australia* (*Oral*). Conference of International Society for Environmental Epidemiology, Basel, Switzerland, August 2013.

5. Ting Xia, Ying Zhang. *Health co-benefit modelling study on active transportation: Model evaluations and sensitivity Analyses (Oral).* The XIX International Conference of the Society for Human Ecology jointly with IV International Conference on Sustainability Science in Asia Conference, Canberra, Australia, February 2013.

AWARDS ARISING OUT OF THIS THESIS

- Swiss TPH Conference Fellowship Program. Swiss Tropical and Public Health Institute. 2013.

- Postgraduate Travelling Fellowships. Faculty of Health Sciences Research Committee, University of Adelaide. 2013.

- Adelaide Scholarship International, University of Adelaide. 2010-2014.

LIST OF ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACS	American Cancer Society
ADM	Atmospheric Dispersion Modelling System
AF	Attributable fractions
ARI	Acute respiratory infections
BAU	Business-as-usual
BenMAP	Environmental Benefits Mapping and Analysis Program
BITRE	The Australian Bureau of Infrastructure, Transport and Regional Economics
CATI	Computer aided telephone interviewing
CI	Confidence interval
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
CO2-e	Carbon dioxide equivalent
CRA	Comparative Risk Assessment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DALY	The disability-adjusted life year
dB	Decibel
DPTI	Department for Transport, Energy and Infrastructure
EC	Elemental carbon
EMMM	Expansion of the multi-city mortality and morbidity study
EPA	Environmental Protection Agency
EPA-MVEI	Environmental Protection Authority Motor Vehicle Emission Inventory database

ERG	Environmental Research Group
FPM/APM	Fine Particles/Aerosol Particle Mass Analyzer
GDP	Gross domestic product
GHGs	Greenhouse gases
HAPiNZ	Application of Health and Pollution in New Zealand
HEAT	Health Economic Assessment Tool
IPCC	International Panel on Climate Change
ITHIM	Integrated Transport and Health Impact Modelling Tool
LAEI	The London Atmospheric Emissions Inventory
LPG	Liquefied petroleum gas
MET	Metabolic equivalent task hours
Mton	Metric ton
NAEI	National Atmospheric Emission Inventory
NAM	Norm-activation model
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxides
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development
OSPM	Operational Street Pollution Model
PAFs	Population attributable fractions
PBC	Perceived behavioural control
PM	Particulate matter
PM_{10}	Particles with an equivalent aerodynamic diameter ≤10 μm
$PM_{2.5}$	Particles with an equivalent aerodynamic diameter ≤2.5 μm
PROS	Population Research and Outcome Studies
QoL	Quality of life
RR	Relative risk

SA	South Australia
SDM	System dynamics modelling
SEM	Meta-analytic structural equation modelling
SIM-air	Simple Interactive Models for better air quality
SO_2	Sulphur dioxide
TAPM	The Air Pollution Model
TAT	Towards Alternative Transport
TPB	Theory of planned behaviour
VAPIS	Vehicle Air Pollution Information System
VEPM	Vehicle Emissions Prediction Model
VKT	Vehicle kilometres travelled
VOCs	Volatile organic compounds
WHO	World Health Organization
YLD	Years lost due to disability
YLL	Years of life lost

ABSTRACT

Background

The increasing number of motor vehicles in urban areas has a significant impact on the environment, as well as, on human health. Motor vehicle emissions contribute a considerable amount of energy-related greenhouse gases and cause non-negligible air pollution. In addition, over-dependence on cars has also encouraged a sedentary lifestyle and an obesity epidemic, which may lead to increased burden of diseases. These health and environmental costs of motor vehicle usage can be reduced by encouraging individuals to change their travel behaviours in order to increase their use of alternative transport. Such a strategy provides an opportunity for collaboration between people working in the transportation, environment and public health areas. However, limited studies currently exist to provide sufficient evidence for policy and interventions relating to this issue.

Aims

The aims of the research presented in this thesis are to improve our understanding of the co-benefit effects of alternative transport and to investigate perspectives from communities and stakeholders on sustainable travel behaviour change in Adelaide, South Australia.

Methods

A mixed-method study design was employed, with three interrelated studies conducted: two quantitative and one qualitative. The first study was focussed on a scenario-based modelling analysis. Separate models, including air pollution, health impact assessment, and traffic injury models, were developed in relation to scenarios for car reduction with

possible environmental and health outcomes, in order to evaluate the overall potential benefits of alternative transport.

The second study involved a cross-sectional survey conducted in the Adelaide metropolitan area. A total of 381 residents were interviewed using the computer-assisted telephone interviewing (CATI) system. Descriptive statistical analysis, factor analysis, Pearson correlations, and multiple logistic regressions were performed to investigate the relationships between participants' attitudes and their travel behaviours and to explore predictors of participants' intention to reduce car use.

The third study presented in the thesis adopted a qualitative approach to explore the perspectives of stakeholders relevant to changing transport behaviours. In-depth interviews with key stakeholders (n=13) were conducted, and a thematic analysis of the resulting transcripts identified some of the particular challenges that must be overcome in order to promote alternative transport.

Results

Results of the first study indicated that the major health benefits associated with the promotion of alternative transport policies related to increased physical activity. In the increased cycling scenarios, it was found that a small shift from car travel to cycling would reduce the burden of disease related to physical inactivity by 17-34% (1991-4132 disability-adjusted life years [DALYs] prevented), compared with a Business As Usual scenario by 2030. Results indicated that important health benefits can also be achieved by increasing public transport use, which involves increasing walking distance and a possible reduction in serious traffic injuries. Although findings from this study do not suggest a large reduction in $PM_{2.5}$ concentration (0.1-0.4 $\mu g/m^3$) associated with alternative

transport use, health benefits (39-118 DALYs prevented) from the reduction of air pollution exposure for the general population should not be ignored.

The results of the cross-sectional survey suggest that there are socio-demographic differences in people's dominant mode of transport, annual driving distance and car use frequency. In general, "Push" measures to reduce car use (e.g., increasing costs associated with driving) were considered less efficient than "Pull" measures (e.g., making alternative transport more attractive). In addition, people's attitudes towards traffic, the environment and health may influence their travel behaviours and intentions to reduce car use. Those who highly rated the importance of safety and comfort and who reported having more negative emotions towards public transport were likely to use cars more often and less likely to shift their travel mode. In contrast, those who indicated a high level of awareness of the benefits of alternative transport and of the problems of traffic were more likely to report an intention to shift travel mode and favour car reduction measures.

Key themes identified in the final qualitative study suggested that barriers to promoting active transport fall into four main areas: (1) existing gaps in knowledge of transport emission impacts, strategies from other countries and the overall benefits of alternative transport, (2) striking a policy balance between alternative transport strategies and economic viability, feasibility, population density, traffic demands, and budget distribution issues, (3) shared ownership of responsibilities, funding and regulations among governments and departments, and (4) public resistance to using alternative transport. Potential solutions suggested by participants to resolve these barriers included government actions, "Push" and "Pull" policy interventions, educational approaches, culture change and evidence-based research.

Conclusion

Findings from the first study reveal that alternative transport use can produce considerable health benefits associated with increased levels of physical activity. This may lead policy makers to pay more attention to transport strategies which especially favour active transport, rather than strategies aimed solely at reducing vehicular emissions (e.g. elevating standards for emissions). The study also revealed that, to achieve significant health benefits through transport policy, travel behaviour change at the population level is essential. Findings from the second study provided a better understanding of current travel behaviour in the study setting. This study also suggested that public education and community campaigns focusing on local residents with sufficient knowledge of traffic issues and benefits of alternative transport, combined with car reduction barriers, could encourage less driving and more pro-environmental travelling. To take the alternative transport agenda forward, high level leadership and commitment from governments are needed to assist in establishing and building collaborative efforts. The findings of the third study fill a gap between policy intention and implementation, and highlight the importance of a 'whole-of-government' policy approach which can strengthen collaborations across relevant policy-makers.

STATEMENT

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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ACKNOWLEDGEMENTS

I would like to sincerely acknowledge and thank the following people for their contribution and help me to make this thesis possible.

I thank firstly, a wonderful supervisory panel, Dr. Shona Crabb, Dr. Ying Zhang, Professor Annette Braunack-Mayer and Dr.Pushan Shah, thanks for your passion, enthusiasm and patience in supporting me through the past four years. Advice and mentorship from Dr. Monika Nitschke and Dr. Alana Hansen were also vital to my journey through the research process and I will always appreciate their contribution and encouragement.

I would also like to thank to all who assisted in providing data, and assistance in modelling methodology. Particular thanks to Mr. Kelvyn Steer, Mr. Rob Mitchell and colleagues from the EPA for guidance with air pollution modelling.

A special thank you to Professor Philip Weinstein, Dr. Scott Hanson-Easey and Dr. Susan Williams Anne for their great support, encouragement and friendship as well as embarked upon the PhD journey. Thank you to Madigan who provided supports to me when I needed. Special thanks to my fellow students, in particular Kerri Beckmann, Mazna Almarzooqi, Shiau Yun Chong, Maoyi Xu, Jianjun Xiang, Si Si, Jane Scarborough, and Ismaniza Ismail, for their friendship and for generously sharing your expertise.

Professional editor, Dr. Arthur Saniotis, was used in the preparation of the thesis for submission, following the guidelines of the Australian Standards for Editing Practice.

Last but certainly not least, my thanks to Jackie my soul mate and best friend for always supporting, helping, and encouraging me and for always keeping me smiling and laughing. Also, a huge thanks to my parents for their continual support, care and encouragement.