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Environmental correlates of adults' walking behaviour

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ENVIRONMENTAL CORRELATES OF ADULTS' WALKING BEHAVIOUR

by

**Nancy Humpel
BPsyc (Hons)**

A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Department of Psychology

University of Wollongong

Australia

2003

DECLARATION

I hereby certify that the material presented in this thesis titled “ Environmental Correlates of Adults’ Walking Behaviour” has not been submitted for the award of any other degree or diploma in any other University or Institution. To the best of my knowledge, this thesis contains no material previously published or written by another person, except where due reference is made in the text.

Nancy Humpel

June, 2003

PUBLICATIONS ARISING FROM THIS THESIS

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine*, 22(3), 188-199.

Humpel, N., Owen, N., Leslie, E., Marshall, A., Bauman, A., & Sallis, J. F. (in press). Associations of location and perceived environmental attributes with walking in neighborhoods. *American Journal of Health Promotion*.

Humpel, N., Marshall, A., Leslie, E., Bauman, A., & Owen, N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*.

CONFERENCE PRESENTATIONS

Humpel N, Owen N, Leslie E & Marshall A. (2002). Associations of objective location and perceived environmental attributes with walking in neighborhood settings. *International Journal of Behavioral Medicine*, 9(Suppl 1), 121. [Abstract]

Humpel N, Leslie E, Iverson D, Jones S, Bauman A, Marshall A & Owen N. Perceptions of the environment and walking behaviour. Paper presented at the Australasian Society for Behavioural Health and Medicine Conference, Brisbane, February, 2003.

TABLE OF CONTENTS

	Page
Declaration.....	ii
Publications and Conference Presentations Arising from this Thesis.....	iii
Table of Contents	iv
List of Tables	ix
List of Abbreviations.....	xi
Abstract	xii
Acknowledgements.....	xvi
Introduction and Context of the Studies.....	xvii

PART 1. LITERATURE REVIEW

1.1 Physical Activity and Public Health.....	1
1.1.1 Physical activity and health outcomes	
1.1.2 Physical activity and public health recommendations	
1.1.3 The importance of walking	
1.1.4 How active are Australians?	
1.2 Understanding the Determinants of Physical Activity	6
1.2.1 Domains of influence on physical activity	
1.2.2 Environmental factors as correlates of physical activity	
1.2.3 Environmental interventions to influence physical activity	
1.2.4 Measuring environmental correlates of walking	
1.3 Understanding Environmental Influences on Physical Activity.....	10
1.3.1 Theoretical context to studying environmental attributes	
1.3.2 Social cognitive models	
1.3.3 Ecological models	
1.3.4 A behaviour- and context-specific approach	
1.4 Environmental Correlates of Physical Activity Behaviour.....	18
1.4.1 Understanding environmental factors associated with adults' walking behaviour	
1.5 Summary and Research aims	32

PART 2. RELIABILITY OF MEASURES OF PERCEIVED ENVIRONMENTAL ATTRIBUTES OF WALKING

2.1	Introduction and Aims.....	35
2.2	Methods.....	36
2.2.1	Study sample	
2.2.2	Design and procedure	
2.2.3	Measures	
2.2.4	Method of analyses	
2.3	Results.....	39
2.3.1	Test-retest reliability of measures of perceived environmental attributes	
2.3.2	Test-retest reliability of measures of walking and physical activity	
2.4	Summary	43
2.5	Limitations of the study.....	44

PART 3. CROSS-SECTIONAL AND PROSPECTIVE ASSOCIATIONS OF ENVIRONMENTAL ATTRIBUTES WITH WALKING: WORKPLACE SAMPLE

3.1	Introduction	45
3.2	Cross-Sectional Study of Associations of Environmental Attributes with Walking Behaviour: Hypotheses and Methods	46
3.2.1	Study sample and procedure	
3.2.2	Measures	
3.2.3	Methods of analysis	
3.3	Cross-Sectional Associations of Environmental Attributes with Walking Behaviour: Outcomes.....	51
3.3.1	Characteristics of participants	
3.3.2	Perceptions of the environment with walking	
3.3.3	Place of residence	
3.3.4	Multivariate analyses: predictors of walking	
3.3.5	Summary of the findings of the cross-sectional study	
3.4	Prospective Study of the Associations of Changes in Environmental Perceptions with Changes in Walking: Hypotheses and Methods	59
3.4.1	Characteristics of participants	
3.4.2	Measures	
3.4.3	Methods of analysis	

3.5 Prospective Relationships of Changes in Perceptions of Environmental Attributes with Changes in Walking Behaviour: Outcomes.....	63
3.5.1 Change in environmental perceptions and walking behaviour	
3.5.2 Multivariate analyses	
3.5.3 Summary of the findings of the prospective study	
3.6 Limitations of the Studies Reported in Part 3	70
3.7 Implications of the Studies	71

PART 4. CROSS-SECTIONAL AND PROSPECTIVE ASSOCIATIONS OF ENVIRONMENTAL ATTRIBUTES WITH WALKING: COMMUNITY SAMPLE

4.1 Introduction	73
4.2 Cross-Sectional Study of Environmental Attributes with Walking Behaviours: Hypotheses and Methods.....	75
4.2.1 Study sample	
4.2.2 Measures	
4.2.3 Methods of analysis	
4.3 A Test of the Replicability of the Environmental Attribute Categories from the Cross-Sectional Study of Part 3 with Neighbourhood Walking, Exercise Walking, Pleasure Walking and Walking to get to from Places.....	79
4.3.1 Methods of analysis	
4.3.2 Results for the test of replicability of Part 3 environmental categories	
4.4 Cross-Sectional Associations of the Broader Set of Environmental Attributes with Walking Behaviour: Outcomes	83
4.4.1 Factor analysis of perceived environmental attributes	
4.4.2 Characteristics of participants	
4.4.3 Bivariate relationships between environmental attributes, participant characteristics and walking behaviours	
4.4.4 Multivariate analyses: predictors of walking behaviour	
4.4.5 Summary of the findings of the cross-sectional study	
4.5 Prospective Study of Relationships of Changes in Perceptions of Environmental Attributes with Changes in Walking Behaviour: Hypotheses and Methods	98
4.5.4 Characteristics of participants	
4.5.5 Measures	
4.5.6 Methods of analysis	

4.6 Prospective Relationships of Changes in Perceptions of Environmental Attributes with Changes in Walking Behaviour: Outcomes 100

4.6.1 Bivariate relationships between changes in environmental perceptions, participants characteristics and walking behaviour outcomes

4.6.2 Multivariate analyses: predictors of walking behaviours

4.6.3 Summary of findings of the prospective study

4.7 Limitations of the Studies Reported in Part 4 107

4.8 Implications of the Studies 108

PART 5. DISCUSSION

5.1 Overview of Findings..... 110

5.2 Limitations of the Studies. 119

5.3 Implications: Future Research Directions 121

5.4 Implications: Public Health Policy and Practice 127

REFERENCES 130

APPENDICES 145

APPENDIX A: Published Papers Associated with this Thesis

A-1: Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine*, 22(3), 188-199.

A-2: Humpel, N., Owen, N., Leslie, E., Marshall, A., Bauman, A., & Sallis, J. F. (in press). Associations of location and perceived environmental attributes with walking in neighborhoods. *American Journal of Health Promotion*.

A-3: Humpel, N., Marshall, A., Leslie, E., Bauman, A., & Owen, N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*.

APPENDIX B: Survey Forms

B-1: Reliability study survey

- B-2: Workplace study baseline survey
- B-3: Workplace study follow-up survey
- B-4: Community study baseline survey
- B-5: Community study follow-up survey
- B-6: Full list of items measuring environmental perceptions in the community studies

APPENDIX C: Additional Table for the Cross-Sectional Study of Part 4

- C-1: Mean scores and standard deviations of environmental items from Part 4

APPENDIX D: Conference presentation based on the data from the cross-sectional study of Part 3: Associations of Objective Location and Perceived Environmental Attributes with Walking in Neighbourhood settings

- D-1: Accepted abstract
- D-2: Handout for poster presentation: the Seventh International Congress of Behavioural Medicine Conference, Helsinki, 2002.

APPENDIX E: Accepted abstract from conference presentation based on the data from the cross-sectional studies of Parts 3 and 4: Perceptions of the Environment and Walking Behaviour

LIST OF TABLES

PART 1	Page
Table 1.1: Patterns of Findings on the Associations for Accessibility of Facilities and Opportunities for Activity, with Physical Activity	24
Table 1.2: Patterns of Findings on the Associations of Weather, Safety and Aesthetic Factors, with Physical Activity	25
Table 1.3: Characteristics and Main Findings from Studies Examining Relationships of Environmental Attributes With a Main Outcome of Walking	29
PART 2	
Table 2.1: Intra-class Correlations and 95% Confidence Intervals for Perceived Environmental Attribute Items for the Total Sample and for Men and Women Separately	40
Table 2.2: Intra-class Correlations and 95% Confidence Intervals for Environmental Perceptions Categories for the Total Sample and Men and Women Separately	41
Table 2.3: Intra-class Correlations and 95% Confidence Intervals for the Total Minutes per Week for each Physical Activity Measure	43
PART 3	
Table 3.1: Characteristics of Participants and Distribution by Location	52
Table 3.2: Mean Minutes and Standard Deviations for Physical Activity Behaviours, and Mean Scores on Perceived Environmental Attribute Categories	52
Table 3.3: Logistic Regression Model Stratified by Gender: Odds Ratios and 95%CI for Location and each Category of Environmental Variables and the Likelihood of being in the Higher Category of Participation for Neighbourhood Walking, Total Walking and Total Physical Activity	56
Table 3.4: Baseline and Follow-up Neighbourhood Walking (minutes/week) and Perceptions Scores for Environmental Attributes for Men and Women	64
Table 3.5: Odds Ratios (95%CI) for Changes in Perceptions of Neighbourhood Environmental Attributes and Their Association with an Increase in Walking Behaviour Among Men and Women	67

PART 4

Table 4.1: Logistic Models Stratified by Gender: Odds Ratios and 95%CI for Location and each Category of Environmental Attributes and the Likelihood of Being in the Higher Level of Participation Category for Neighbourhood and Exercise and Walking	82
Table 4.2: Factor Loadings from Principal Component Analysis using Varimax Rotation	84
Table 4.3: Characteristics of the Sample and Distribution by Location	86
Table 4.4: Means and Standard Deviations for Minutes of Walking, by Type and by Scores on Perceived Environmental Attribute Factors	86
Table 4.5: Proportions of Participants in the High Level of each Type of Walking for Gender, Age and Education level and by Perceived Environmental Factors and Location.	88
Table 4.6: Logistic Regression Models for Men: Odds Ratios and 95%CI for Location and each Environmental Variable Factor and Likelihood of Being in the High Category of Participation for each Walking Type	92
Table 4.7: Logistic Regression Models for Women: Odds Ratios and 95%CI for Location and each Environmental Variable Factor and the Likelihood of Being in the High Category of Participation for each Walking Type	93
Table 4.8: Baseline and Follow-up Walking (minutes/week) and Perception Scores for Environmental Attributes for Men and Women.	103
Table 4.9: Mean Minutes (SD) of Follow-up Neighbourhood and Exercise Walking by Baseline Level for each Perceived Environmental Factor.	103
Table 4.10: Follow-up Mean Minutes of Walking by Gender and Location	104
Table 4.11: Odds ratios (95%CI) for Changes in Perceptions of Neighbourhood Environmental Attributes and Their Association with an Increase in Walking Behaviour Among Men and Women	106

PART 5

Table 5.1: Summary of the Significant Associations from the Cross-Sectional Studies for each Environmental Category and Neighbourhood Walking, Exercise Walking, Walking for Pleasure and Walking to Get to and From Places.	118
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LIST OF ABBREVIATIONS

The following abbreviations are used within this thesis

CDHAC:	Commonwealth Department of Health and Aged Care
GIS:	Geographic Information Systems
ICC:	Intraclass correlations
IPAQ:	International Physical Activity Questionnaire
NHMRC:	National Health and Medical Research Council
NSW:	New South Wales
SCT:	Social Cognitive Theory
SPSS:	Statistical Package for the Social Sciences
SQL:	Structured Query Language function
USA:	United States of America
USDHHS:	U.S. Department of Health and Human Services

ABSTRACT

Physical inactivity is associated with increased risk of developing chronic diseases. The evidence linking physical activity and health outcomes has led to the development of national physical activity guidelines, which focus on moderate-intensity activities.

Walking is the most commonly reported moderate-intensity activity and is arguably the most relevant activity for public health interventions targeting adults.

Public health strategies to increase participation in physical activity are now starting to focus on supportive factors in the physical environment. A behaviour-specific ecological approach was taken in this thesis. Ecological models of physical activity behaviour identify multiple levels of influence from intrapersonal, interpersonal, social and broader environmental domains, with particular attention to the physical environment.

A literature review of studies that assessed associations of environmental attributes with physical activity found research on environmental influences shows promise to identify significant and potentially modifiable influences on physical activity in general, and specific to walking behaviour. Studies were found to be limited to cross-sectional design and a need was identified for both prospective and intervention studies in order to advance the field.

The main aims of this thesis were to develop and test measures of perceptions of environmental attributes; to examine cross-sectional relationships of perceptions of environmental attributes and an objective measure of location with walking behaviour;

and, to examine prospective relationships of changes in environmental perceptions with changes in walking behaviour. The studies of these relationships are reported for a workplace sample in Part 3 and for a community sample in Part 4.

The cross-sectional study of Part 3 found for men, significant positive relationships for ‘aesthetics’ ‘convenience’ ‘access’ to services, and for coastal place of residence with neighbourhood walking; and a negative relationship emerged for ‘traffic’ as a problem with neighbourhood walking. For women, a significant positive relationship was reported for ‘convenience’ and a negative relationship with ‘access’ to services with neighbourhood walking. Fewer significant relationships were found for total walking and total physical activity.

The prospective study of Part 3 found for men, improved perceptions of ‘convenience’ and ‘aesthetics’ were positively associated with increased neighbourhood walking, and improved perceptions of ‘access’ to services were negatively associated with increased walking. For women, improved perceptions of ‘convenience’ and ‘traffic’ were positively associated with increased neighbourhood walking.

Part 4 expanded on the studies of Part 3 by increasing the range of perceptions of the environment measured, and by examining a greater number differentiated walking outcome measures including: neighbourhood walking, walking for exercise, pleasure and walking to get to and from places. A principal components analysis found four main factors underlying the items measuring environmental attributes, these were: ‘aesthetics’ ‘accessibility’ ‘safety’ and ‘weather’. The cross-sectional study of Part 4, found more significant relationships of environmental perceptions with walking for men compared

to women. In this study, living in a coastal location was associated with women being more likely to do more neighbourhood walking. Different environmental attribute categories were found related to different types of walking. ‘Weather’, ‘aesthetics’, ‘accessibility’ and ‘location’ were associated with neighbourhood walking. ‘Weather’ and ‘aesthetics’ were found to be associated with walking for exercise. ‘Safety’ and ‘accessibility’ were associated with walking for pleasure. None of the environmental attributes were found to be associated with walking to get to and from place to places.

Results for the prospective study of Part 4 found baseline perceptions of environmental attributes were related to perceptions at follow-up, but not at a multivariate level of analysis. Changes in perceptions of the neighbourhood environment over time were not found to be associated with changes in any of the four walking outcomes. The variation in findings of the two prospective studies may be due to differences between the samples in age, educational attainment, methods of assessment and sample size.

The diverse directions of association emphasize that further work is needed on the development and refining of measures of perceptions of the environment. Future research should also compare measures of perceptions with objectively measured environmental attributes to provide evidence of validity for self-report perceptions. The strong gender differences found in the studies of this thesis highlight the need to carry out gender-specific analyses in physical activity studies.

This thesis has overall, given support to the importance of examining the influence of environmental factors on adults’ walking behaviour. It is recommended that future research now needs to go beyond looking at environmental variables on their own, and

include the strongest individual and social factors in future multi-level prospective studies. Even if small amounts of variance in physical activity are explained by environmental factors, these many small effects across communities could accumulate to mean substantial physical activity changes across populations.

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INTRODUCTION AND CONTEXT OF THE STUDIES

A large body of evidence has accumulated on the importance of physical activity for reducing the risk of chronic diseases that are the leading cause of morbidity and mortality in industrialized nations. Understanding the ‘determinants’ or correlates of physical activity is an important pre-requisite to attempts to increase activity levels in populations, by developing new interventions and programs.

This thesis deals with factors in the physical environment that may be potential correlates of adults’ walking behaviour. The conceptual framework for the studies in this thesis is based on the ecological approach, in particular, a behaviour-specific ecological approach. A behaviour-specific model allows for differing aspects of the environment that may be related to particular physical activity behaviours. The particular behaviour that is the focus of this thesis is walking.

This thesis is divided into 5 Parts. Part 1 describes the background and rationale for the study of environmental correlates of physical activity and walking. A literature review was conducted that examined studies that had explored associations of environmental attributes with physical activity behaviour. A summary of the studies that explicitly examined associations of environmental attributes with the specific behaviour of walking is presented. The theoretical underpinnings for the study of the influence of environmental attributes on physical activity are described and the ecological approach taken for the studies of this thesis is explained.

The literature review found a scarcity of measures of environmental perceptions with psychometric properties. Part 2 is a measurement study - specifically a study of the test-retest reliability of measures of perceptions of environmental attributes and measures of walking behaviours.

Part 3 reports findings for two studies using a workplace sample. A cross-sectional study was conducted of associations of perceptions of environmental attributes and an objective measure of residential location with neighbourhood walking, total walking and total physical activity. The second study reported in Part 3 is a prospective study of changes in perceptions of the environment over time and their associations with changes in neighbourhood walking.

Part 4 replicates the format of the studies of Part 3, incorporating an extended range of measures based on the results of Part 3. Part 4 reports findings from two studies; a cross-sectional and a prospective study using a community sample.

Part 5 gives an overview of the findings from the studies of Parts 3 and 4 of the thesis. The implications of the studies and directions for future research are suggested. Implications for public health practice and policy are discussed.

The data reported in Parts 3 and 4 of this thesis are from studies that were embedded in what were designed as larger intervention studies. The study reported in Part 3 was carried out within the context of a physical activity intervention trial designed to test the efficacy of a website-delivered self-help physical activity program compared to a print self-help program in a workplace setting (Marshall et al., in press). This project was

supported by a Heart Foundation Project Grant and co-ordinated by a team that included Professor Neville Owen, Dr Alison Marshall and Dr Eva Leslie. I worked with the research team on this project and was responsible for some elements including the usability testing of the website. I am very grateful to the team for allowing me to include the items for my studies as part the overall surveys of the project.

The study of Part 4 was carried out within the context of a walking intervention trial designed to compare the efficacy of a print self-help walking program with a print self-help plus telephone contact program to increase levels of walking in a community sample of adults. I developed this program for the Australian Health Management Group (AHMG) under the supervision of Professor Don Iverson, which gave me access to resources and support I would not otherwise have had available. Although this intervention trial was not the focus of my thesis, by designing and managing this trial for AHMG, I was able to include the necessary items pertaining to my focus, which was explicitly on environmental attribute relationships with walking behaviour.

PART 1

LITERATURE REVIEW¹

1.1 Physical Activity and Public Health

1.1.1 Physical activity and health outcomes

The link between physical activity and several health benefits has now been well established (USDHHS, 1996; Pate et al., 1995). National and international bodies such as the Australian Public Health Association, the Centers for Disease Control and Prevention and the American College of Sports Medicine in the USA have emphasized the importance of regular physical activity in reducing the risk of chronic disease. The general consensus is that population wide participation in regular physical activity will reduce the burden from coronary heart disease (Wanamethee, Shaper, & Walker, 1998), hypertension (Kesaniemi et al., 2001), type 2 diabetes (Kelley & Goodpaster, 2001), osteoporosis (Thune & Furberg, 2001), and some cancers (Kiningham, 1998; Thune & Furberg, 2001). The benefits of physical activity to psychological health have been documented. Physical activity can relieve symptoms of anxiety and depression and may help reduce the risk of psychological disorders (Buckworth & Dishman, 2002; Sallis & Owen, 1999). Physical activity has also been found to be associated with maintaining a healthy body weight and should help to prevent excess weight gain (Ball, Owen,

¹ The literature review reported in Part 1.4 has been published as Humpel N, Owen N, & Leslie E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine*, 22(3), 188-199. It can be found in Appendix A-1.

Salmon, Bauman, & Gore, 2001; DiPietro, 1995; Salmon, Bauman, Crawford, Timperio, & Owen, 2000).

1.1.2 Physical activity and public health recommendations

The evidence linking physical activity and health outcomes has led to the development of national physical activity goals and guidelines. The current public health message is that the most important population health benefits of physical activity can be obtained at moderate intensities and volumes of activity. The physical activity recommendations are that every adult should accumulate 30 minutes or more of moderate-intensity activity over the course of most days of the week (USDHHS, 1996). This recommendation has been incorporated into national guidelines for physical activity in Australia and the USA (Commonwealth Department of Health and Aged Care, 1999; USDHHS, 1996). The National Physical Activity Guidelines for Australians were developed as a result of recommendations arising from the National Health and Medical Research Council (NHMRC) Report *Acting on Australia's Weight: a Strategic Plan for the Prevention of Overweight and Obesity* (National Health and Medical Research Council, 1997). These guidelines have been promoted by the Commonwealth Department of Health and Aged Care (CDHAC; Commonwealth Department of Health and Aged Care, 1999) in collaboration with the Australian Sports Commission under the 'Active Australia' banner.

The Australian guidelines stress the importance of thinking of physical activity as an opportunity to improve health rather than as a time-wasting inconvenience. The

National Physical Activity Guidelines for Australians (Commonwealth Department of Health and Aged Care, 1999) are:

1. Think of movement as an opportunity, not an inconvenience.
2. Be active every day in as many ways as you can.
3. Put together at least 30 minutes of moderate-intensity physical activity on most, preferably all, days.
4. If you can, also enjoy some regular, vigorous exercise for extra health and fitness.

The focus is on being generally more active and on moderate-intensity activities. Moderate-intensity activity causes a slight, but noticeable, increase in breathing and heart rate. The recommended 30 minutes of physical activity can be done in a single bout or 'accumulated' in multiple bouts with each lasting at least 10 minutes. Relevant studies have concluded that substantial amounts of intermittent activity can be as beneficial to health as activity in a continuous session (DeBusk, Stenestrand, Sheehan, & Haskell, 1990; Pate et al., 1995; Sallis & Owen, 1999). Examples of moderate-intensity activities include climbing stairs, bicycling at an easy pace or brisk walking.

1.1.3 The importance of walking

For public health interventions, walking is arguably the most relevant moderate-intensity activity and is the option of choice for increasing physical activity in sedentary populations. It has been found that when directed to walk 'briskly',

individuals walk at a pace that at a minimum, meets the moderate–intensity guidelines (Murtagh, Boreham, & Murphy, 2002). Walking is the natural form of mobility, and is the only sustained aerobic activity that is common to the majority of the population (Morris & Hardman, 1997). It can be done year round, no special skills or training are necessary, and walking duration, frequency and intensity are determined by the individual. Walking is the ideal way for the sedentary to slowly develop habitual physical activity. Walking can be done for exercise, leisure, as part of a person’s occupation, and as transport to get from place to place. Low levels of participation in walking as part of the workday, and low rates of walking for transport are contributing factors towards today’s sedentary lifestyle (Saelens, Sallis, & Frank, 2003). Unlike more vigorous activities that show large declines in levels of participation over the lifespan, little decline of regular walking is reported across age groups (Armstrong, Bauman, & Davies, 2000).

1.1.4 How active are Australians?

The physical activity patterns of Australian adults were assessed in a national population survey in 1999 and the findings were compared with the 1997 Active Australia baseline survey (Armstrong et al., 2000; Bauman et al., 2003). The average amount of time spent each week in leisure-time physical activity was found to decline between 1997 and 1999. The proportion of adults meeting the criteria for ‘sufficient’ physical activity for health benefits (a total of at least 150 minutes per week) dropped from 63.1% in 1997 to 54.9% in 1999 (Bauman et al., 2003). Participation in ‘sufficient’ activity (meeting the guidelines) increased with education, and declined with age until 60 years where there was then a slight

increase. The mean time spent in vigorous activity declined (91 to 65 minutes per week) as did the mean time spent in moderate-intensity activities (62 to 54 minutes per week); walking declined from 137 to 114 minutes per week (Armstrong et al., 2000). The decline in activity was greatest for those less than 45 years; older adults showed no decline in activity. Although initiatives to promote physical activity in the population have been under way for a few decades now, it would seem that the physical activity levels of Australians adults are declining.

The Australian Report on Sport and Physical Activities (Australian Bureau of Statistics, 2000) identifies walking as the most common form of moderate-intensity activity in Australia during the 12 months 1999-2000, with an 18.8% (approximately 2.58 million) participation rate. Women (23.8%) were found to participate more in walking than men (13.7%).

A study across 45 states of the USA (Siegel, Brackbill, & Heath, 1995) found that among the many leisure-time physical activities, walking was found to be about half of all leisure-time exercise. Relatively little variation across age groups was found with 65-74 years olds reporting the highest percentage (31%) of walking for exercise. The prevalence of walking was highest among the lower socio-economic status groups that usually report the lowest levels of leisure-time physical activity.

Walking is argued to be a 'natural' and common form of physical activity. It is seen to be the main option for increasing activity in sedentary populations. Walking promotions may prove to be more effective for increasing regular physical activity than programs that promote a general increase in activity (Bauman, Bellew, Owen,

& Vita, 2001). In order to develop effective interventions and systematic programs to increase activity levels in the population, it is necessary to first develop a strong evidence base on the factors that are associated with physical activity in general, and walking in particular.

1.2 Understanding the Determinants of Physical Activity

1.2.1 Domains of ‘determinants’ of physical activity

Identifying factors that are correlated with physical activity is an important preliminary step towards designing effective programs to increase population wide physical activity. There is a large body of literature on the ‘determinants’ of physical activity. In a strict sense, the word ‘determinant’ is inappropriately used. Determinant has been used to describe factors found associated or correlated with physical activity (Bauman, Sallis, Dzewaltowski, & Owen, 2002). Few variables have been identified as true determinants, or direct ‘causes’ of physical activity; most studies have been cross-sectional in design and thus have identified only the correlates of physical activity participation.

Several earlier reviews have been published on the factors associated with physical activity (Dishman, 1990; Dishman & Sallis, 1994; Dishman, Sallis, & Orenstein, 1985; Sallis & Owen, 1999). The most recent review (Troost, Owen, Bauman, Sallis, & Brown, 2002) updated the Sallis & Owen (1999) review of 300 studies, with an additional 38 studies published up to September 2000. Factors associated with physical activity in adults were classified under five main domains:

demographic and biological; psychological, cognitive and emotional; behavioural attributes and skills; social and cultural; and physical environment. Consistently documented associations were found for all categories. Age and gender remain the most consistent demographic correlates, while self-efficacy for physical activity was found to be the most consistent psychological correlate. Barriers to physical activity also demonstrated a strong influence, as did social support for physical activity. The majority of variables that have been studied to date fall into the first four domains. Studies on the role of the physical environment on physical activity are more limited (Troost et al., 2002).

1.2.2 Environmental factors as correlates of physical activity

An increase in the number of studies examining the influence of the physical environment on physical activity was noted in the most recent review (Troost et al., 2002), with the addition of 10 new variables being examined in this category. This reflects an increasing recognition of the importance of environmental factors in influencing physical activity behaviour. These environmental correlates of physical activity are addressed in greater detail in Part 1.4. Until recently, physical activity research had mainly focused on intrapersonal correlates of activity. This approach places emphasis on the individual, with limited consideration of the context within which activity takes place. Physical activities take place in specific environments that are likely to influence the type and amount of physical activity. The environment may or may not provide cues and opportunities for a person to be active.

1.2.3 Environmental interventions to influence physical activity

Although policy and environmental interventions to promote physical activity are being promoted widely, there are few studies that have evaluated these types of interventions to date. Environmental interventions usually include supporting environments that favour activity and providing access to suitable facilities and programs (Baker, Brennan, Brownson, & Houseman, 2000; Brownson, Baker, Houseman, Brennan, & Bacak, 2001). A simple low-cost intervention was conducted in a public place with signage to promote the use of stairs in preference to escalators or lifts (Blamey, Mutrie, & Aitchison, 1995). After the signs were placed, stair-walking rates were observed to double, although 75% of those observed still chose the escalator. Rates of stair usage declined when the signs were removed.

Simple environmental changes (for example, building bicycle paths, supplying new exercise equipment) at a US naval base resulted in an increase in fitness over a one year period compared to a control community (Linenger, Chesson, & Nice, 1991). Although these environmentally focussed intervention studies show promise, they do not yet demonstrate that environmental interventions are more, or even as effective, as those using interpersonal approaches.

1.2.4 Measuring environmental correlates of walking

Whereas the measurement of physical activity is an established field of research, studies evaluating measures of environmental attributes in relation to physical

activity are at an early stage. The development of reliable and valid measures of environmental attributes is in progress in a few studies. Sallis and colleagues (Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997) conducted a one-week test-retest reliability of some neighbourhood items (neighbourhood features, safety, character) and found an intraclass correlation reliability rating of 0.68 for the total scale.

Another study was identified that examined the test-retest reliability of a Neighbourhood Environment Walkability Scale (Saelens, Sallis, Black, & Chen, in press). This scale measured environmental characteristics including residential density, walking/ cycling facilities, aesthetics and traffic safety. Five of the eight sub-scales evidenced a high level of consistency with test-retest intra-class correlations above .75.

Kirtland et al. (Kirtland et al., 2003) examined three-week test-retest reliability for items measuring perceptions of neighbourhood and community supports (access, characteristics, barriers, social issues). They found retest results slightly higher for the neighbourhood items, with Spearman rhos ranging from 0.42 to 0.74 overall. The authors also assessed the validity of their items measuring environmental perceptions by comparing them to objective measures using Geographic Information Systems (GIS). Overall low agreement between measures was found for neighbourhood and community items (Kappa statistic ranged from -0.02 to 0.37). There is also a need to develop behaviour-specific items that address, and assess, attributes specific to a particular behaviour in a particular context or setting.

1.3 Understanding Environmental Correlates of Physical Activity

Theoretical models of health behaviour change have been used to expand the understanding of factors that influence physical activity participation. They help to define plausibly related variables and have mainly focussed on cognitive, affective and social influences (King, Stokols, Talen, Brassington, & Killingsworth, 2002). Theories focussing on intrapersonal processes (for example, attitudes, intention, beliefs) such as the Theory of Planned Behaviour, the Theory of Reasoned Action and the Transtheoretical Model, have been applied to understanding the determinants of physical activity behaviour (Godin, 1994).

1.3.1 Theoretical context to studying environmental attributes

The ecological approach taken in this thesis builds on work that historically comes from public health and psychology. From psychology, environment-behaviour research is a converging of ecological and environmental psychology (Stokols, 1977b). Environmental psychology was generally organised around concern for the analysis of, and solutions to community problems. Emphasis was on the way in which psychological and social processes interact with the physical environment, resulting in differing patterns of behaviour. Ecology, the study of interrelations between the organism and its environment, has its origins in biology and sociology (Stokols, 1977a). In these fields, systematic attempts were made to apply an ecological approach to the study of the relationships of particular units of the environment with particular behaviours. The first attempt to develop an ecological

approach within psychology came from Roger Barker with his conceptualisation of “behaviour settings” (Barker, 1968; Stokols, 1977a).

A theme of the behaviour setting construct is that the setting is not just a passive background where people carry out behaviours they have chosen. People are but one component of the larger behaviour setting, which can restrict the range of behaviours by promoting some, and discouraging others (Wicker, 1979). The environment is not limited to a single immediate setting (Bronfenbrenner, 1979), but is extended to include an environment consisting of a nested arrangement of increasingly larger settings. Bronfenbrenner uses the analogy of a set of Russian dolls where each doll is nested within the next larger doll.

To differentiate the different levels of external influence, three levels of structures are described (Bronfenbrenner, 1979). The most explicit to the individual is the microsystem, which consists of specific settings where face-to-face interactions can take place. The mesosystem comprises the interrelations among multiple settings, for example among family, at work and social life. A mesosystem is therefore a system of microsystems. The exosystem refers to the larger social system that does not involve the person as an active participant directly. The macrosystem refers to the consistencies in the lower-order systems that exist at the level of culture as a whole (for example, schools exist and function in a similar way across different countries).

In the field of public health, the ecological perspective has been applied in health promotion (McLeroy, Bibeau, Steckler, & Glantz, 1988; Stokols, 1992). McLeroy

and colleagues developed a variation of Bronfenbrenner's systems model (Bronfenbrenner, 1979) that described five levels of influence on behaviour. These are intrapersonal factors, interpersonal processes, institutional factors, community factors and public policy. This model did not specifically identify the physical environment as a factor.

More recently, for measurement and study in public health, other researchers have used the terms of aggregate, contagion, environmental, structural and global as means of classifying ecological variables (Blakely & Woodward, 2000). Cohen and colleagues (Cohen, Scribner, & Farley, 2000) propose a structural model of population-level health behaviour that includes four factors: availability (consumer products associated with health outcomes), physical structures (characteristics of structures that reduce or increase opportunities for healthy behaviours), social structures (laws and policies), and cultural and media messages (messages and images heard or seen frequently). The four factors have the ability to complement each other.

MacIntyre & Ellaway (2000) posit an important distinction between compositional (different types of individuals) and contextual (features of the social and physical environment) explanations for variations in outcomes such as health behaviours. Recognition that the context may influence health can direct attention to interventions at the environmental level (MacIntyre & Ellaway, 2000).

1.3.2 Social cognitive models

A theory that has been extensively used to try to understand and explain health behaviours is Social Cognitive Theory (SCT; Bandura, 1986). Constructs from this theory have been widely used in developing interventions to influence health-related behaviours (King, Rejeski, & Buchner, 1998; Marcus, Bock, Pinto, Forsyth, Roberts, & Traficante, 1998; Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998). Bandura (1986) advocates a position that he called ‘reciprocal determinism’. According to this concept, the environment can influence behaviour and behaviour can also influence the environment. Personal factors (cognitions) determine and are determined by both behaviour and the environment. Reciprocal determinism posits that internal mental events, external environmental events, and overt behaviour all influence each other (Baranowski, Perry, & Parcel, 2002). Bandura has argued, “The relative influence exerted by the three sets of interacting factors will vary for different activities, different individuals, and different circumstances. When environmental conditions exercise powerful constraints on behaviour, they emerge as the overriding determinants” (Bandura, 1986, p29).

Although social-cognitive theory identifies environmental influences, most research based on the SCT focuses on individual variables such as self-efficacy (confidence in one’s abilities) and outcome expectancies, and the social aspects of the environment such as observational learning (Baranowski, Perry, & Parcel, 1997; Baranowski et al., 2002). The physical environment is less strongly emphasized in SCT than are cognitive factors such as self-efficacy and outcome expectancies.

A model proposed by Sallis & Hovell (1990), expanded on Social Learning Theory (an earlier version of SCT; see Bandura, 1977) to explain variations in physical activity levels. This model utilised information about personal, cognitive, social and environmental factors to explain patterns of physical activity. These factors included self-efficacy, age, family and peer influences and access to facilities. A key element of the Sallis and Hovell (1990) model of physical activity behaviour was the inclusion of the role of environmental settings and supports. Environments that lack resources, or impose barriers may act to reduce the probability that the choice to be active will be made.

1.3.3 Ecological models

The limitation of individually focussed theories of health behaviour research and promotion, and the need for a more comprehensive approach has been identified (Cohen et al., 2000; Dzewaltowski, 1997; Green, Richard, & Potvin, 1996; Nutbeam, 1997; Spence & Lee, 2003; Stokols, 1996). Ecological models of health behaviour identify multiple levels of influence and aim to take into account the role of environmental influences (Sallis, Bauman, & Pratt, 1998; Sallis & Owen, 1997, 1999). The explicit emphasis on physical environment factors as potential influences in the complex network of causality is the key feature of ecological models as applied to physical activity research (Sallis & Owen, 1997, 2002).

Ecological models posit that it is important to understand the multiple levels of influential factors, including psychological, social, policy and physical environment, that may influence behaviour (Bauman, Sallis, & Owen, 2002;

Duncan, Duncan, Strycker, & Chaumeton, 2002; Sallis & Owen, 1997, 1999, 2002). Environmental and policy variables may add additional explanatory value to individual and social variables (Sallis et al., 1998).

As previously mentioned, an important construct of ecological models is the concept of 'behaviour settings' (Barker, 1968; King et al., 2002; Owen, Leslie, Salmon, & Fotheringham, 2000; Sallis et al., 1998; Sallis & Owen, 1997). Behaviour settings are the physical and social contexts in which behaviours occur, some being supportive of activity, others discouraging or prohibiting of activity (Sallis et al., 1998; Sallis & Owen, 1997, 1999, 2002; Wicker, 1979). There is some support in the literature that much of the functioning of everyday life is driven by the 'cues' from environmental settings and behaviour is conducted as 'automatic'. Features in the current environmental setting can drive behaviours without mediation by conscious reflection or choice (Bargh, 1997; Bargh & Chartrand, 1999; Bargh & Ferguson, 2000). This process has not yet been examined in physical activity research.

There is increasing interest in the use of ecological models of health behaviour as frameworks for understanding the factors that influence physical activity in the population. Sallis & Owen (1997, 1999, 2002), have argued for using an ecological approach for understanding the determinants of physical activity behaviour, and have noted the distinction between social and physical environmental influences. Within the physical environment level factors, natural environment factors such as the weather or climate, and built environment factors,

such as urban design or availability of facilities can influence physical activity behaviour (King et al., 1995; Sallis & Owen, 2002).

The incorporation of physical environment variables into interventions aimed at promoting healthy behaviours like physical activity, is advocated by King and colleagues (King et al., 1995). Policy changes and environmental approaches may arguably have a great impact because they can influence whole communities, are long term and less costly. The population is passively exposed. They cannot avoid being in contact with an environmental intervention unless they move locality (Cohen et al., 2000).

1.3.4 A behaviour and context specific approach

An overall ecological approach to health behaviour generally is complex and difficult to operationalise (Green et al., 1996; Richard, Potvin, Kishchuk, Prlic, & Green, 1996). However, more-specific ecological models can be used to shape and inform research and interventions for specific health behaviours (Sallis & Owen, 1997, 2002). While the broad constructs of ecological models can be described across all health behaviours, when applying the principles in research, the specific behaviour and associated variables must be more clearly and precisely described (Green et al., 1996; Sallis & Owen, 2002).

There is a particular need for specific ecological models for specific physical activity behaviours, as the different types of activity are often performed in distinct settings (Bauman et al., 2002; Owen et al., 2000; Sallis & Owen, 2002). For

example, participation in walking often happens in a neighbourhood setting, whereas fitness training is often done in gymnasiums or health clubs.

In understanding the influence of the physical environment on physical activity behaviour, it is important to examine objectively-observable environmental factors such as distance to facilities (Sallis et al., 1990; Troped et al., 2001) and the location of participants' homes (Bauman, Smith, Stoker, Bellew, & Booth, 1999). For example, an Australian study found that coastal place of residence was associated with adults being more likely to be physically active (Bauman et al., 1999). It is also important to understand the influence of perceptions of particular environmental attributes such as the aesthetic nature of the environment (Ball, Bauman, Leslie, & Owen, 2001; King et al., 2000; Wilcox, Castro, King, Houseman, & Brownson, 2000), or whether suitable places for activity are perceived to be accessible or conveniently located (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; Hovell et al., 1989).

Based on the above argument for specific explanatory models for different types of physical activity, the focus of this thesis is on the physical activity behaviour of walking.

Environmental approaches to physical activity promotion can potentially benefit the total population because the benefit is for all people exposed to the environment rather than attempting to change the behaviour of individuals or sub-groups of the population. However, because environmental attributes are among the least understood of the known influences on physical activity, before effective

interventions can be properly developed it is necessary first to identify the environmental attributes that are associated with physical activity.

1.4 Environmental Correlates of Physical Activity Behaviour

In order to examine the state of the evidence in the literature supporting the environment-behaviour relationship, a review of published quantitative studies was conducted in early 2001. A later updated review examining the literature specific to walking is reported in Part 1.4.1.

When reporting on studies that have examined associations between environmental attributes and physical activity it is necessary to comment on the findings from the transportation and urban design literature (King et al., 2002). Transportation and urban planning researchers have examined the ways the physical environment impact upon vehicular use as opposed to walking and cycling (Saelens et al., in press; Saelens et al., 2003). Whilst the importance of this literature is acknowledged, this thesis and the literature review does not go into detail on the findings, as there are numerous shortcomings to the transportation studies when viewed from a physical activity and health viewpoint (for example, limitations to the quality of measurement of physical activity). In the near future, there may be some convergence of transportation and urban planning with health behaviour research (Saelens et al., 2003).

The aim of the literature review was to provide a systematic overview of the measures that have been used to assess environmental attributes and also to review

the patterns of environment-behaviour associations that had been identified.

Nineteen quantitative studies were identified that examined relationships between particular physical environment attributes and physical activity behaviours in adults, of which 16 had examined the relationship between the perceived physical environments and physical activity. Four of the studies had used objective measures of the environment, including place of residence (using postal codes), physical distance and accessibility of facilities. One study had included both perceived and objective measures. Only one study reported prospective data on the relationship of environmental variables to physical activity change.

A brief summary of the findings is reported here. For the full findings of studies examining relationships between perceived environmental attributes and physical activity among adults, refer to Tables 1 and 2 of the review paper (Humpel, Owen, & Leslie, 2002) in Appendix A-1.

Studies using self-report or perceived measures of environmental attributes.

The earliest self-report study identified (Sallis et al., 1989) examined the cross-sectional relationships of variables reflecting constructs from social learning theory (self-efficacy, modelling, family and friend support and barriers) with vigorous exercise. A 'neighbourhood environment' variable (safety and ease of exercising in the neighbourhood and frequently seeing others exercise) did not emerge as a barrier to vigorous exercise. Neighbourhood environment and convenience of facilities were not significantly associated with reported vigorous exercise. A second study using the same items and participants (Hovell et al., 1989), found a weak association of 'neighbourhood environment' with walking for exercise. A

subsequent prospective study with the same participants (Sallis, Hovell, & Hofstetter, 1992) found neighbourhood environment, convenience of facilities and home equipment to be predictors of change in vigorous activity over 24 months in men only. Sallis et al., (1997) found home equipment to be associated with doing strength exercises and Booth and associates (Booth et al., 2000) found accessibility of local facilities to be positively associated with older adults being categorized as sufficiently physically active in their leisure time for health benefits.

Sallis et al. (1997) developed 43 items to assess physical environment variables in college students. Presence of home equipment was associated with strength exercise and vigorous exercise; convenient facilities were associated with strength exercise (environmental variables explained 7% of the variance in strength exercise). In adjusted multivariate analysis, only home equipment was significantly associated with strength exercise. Booth and associates (Booth et al., 2000) attempted to identify social-cognitive and perceived environmental influences associated with physical activity in older adults. In a multivariate analysis, reported access to a park and perceiving footpaths as safe for walking were significantly associated with being categorized as sufficiently physically active for health benefits.

Sallis et al. (1997) also examined perceptions of the qualitative aspects (aesthetics) of neighbourhoods. They found a neighbourhood environment scale was not related to any measure of physical activity. They hypothesized that the lack of association may have been because, if the neighbourhood is not perceived safe, convenient and enjoyable for physical activity, then people may be active in other environments,

away from the local neighbourhood. Ball et al. (2001) grouped items as perceptions of the 'aesthetic nature of the environment' and 'convenience of the environment'. Those reporting a less aesthetically pleasing (OR = 0.59, 95% CI = 0.47-0.75) and less convenient environment (OR = 0.64, 95% CI = 0.54-0.77) were less likely to report walking for exercise.

King et al. (2000) examined the same neighbourhood variables as Sallis and associates and also a number of specific barriers in a sample of women aged over 40 years. The two environmental barriers identified (lack a safe place to exercise, poor weather) were not related to being active. The neighbourhood characteristics of hills (OR = 1.46, 95% CI = 1.22-1.75), enjoyable scenery (OR = 1.42, 95% CI = 1.12-1.79), and unattended dogs (OR = 1.20, 95% CI = 1.01-1.42) were found to be significantly associated with physical activity.

Studies Using Objectively Assessed Environmental Measures. Sallis et al. (1990) assessed the density of facilities near each participant (on a grid-map) and found significant associations between the density of neighbourhood pay exercise facilities and frequency of exercise, but no relationship with free facilities. Postal code area was used by Bauman and associates to objectively identify place of residence of Australian adults (Bauman et al., 1999). A respondent was categorized as a 'coastal' resident if his/her postal code touched the coastline; those in all other postal code areas were categorized as 'inland' residents. Adult respondents who lived at a coastal postal code area were 23% less likely to be inactive, and 38% more likely to report vigorous exercise

The physical environment was also assessed using geographically-derived data by Giles-Corti and Donovan (2002a). Spatial access (distance by road) to recreational facilities (both natural and built) was not found to be associated with activity and neither was functional environment (whether the participant's street had footpaths and visible shops) nor the appeal of the environment (volume of traffic and number of trees). However, unlike most of the other studies reviewed, a composite measure of all four variables demonstrated that a supportive physical environment had a significant association with the likelihood of being active (OR = 1.43, 95% CI = 1.09-1.88).

Patterns of findings. The items dealing with environmental attributes that were extracted from the papers in the review may be categorized within five sets of logical groupings: accessibility of facilities; opportunities for activity; weather; safety; and aesthetics. At this early stage of research on the associations of environmental attributes with physical activity behaviour, this is most appropriately a descriptive integration with some face validity, rather than proposed definitive constructs. These 'logical' groupings and the direction of their association can be found in Tables 1.1 and 1.2. Safety, while not of itself an actual physical environment attribute, is plausibly related to factors in the physical environment (for example, street lighting or the presence of sidewalks) that would affect perceptions of safety. For the studies referred to by study citation numbers in Tables 1.1 and 1.2, refer to Humpel et al. (2002) in Appendix A-1.

Findings of studies relating to accessibility of facilities, opportunities for physical activity and the direction of these associations are summarised in Table 1.1.

Findings pertaining to weather, items about safety while being active, and items regarding the aesthetic nature of the physical environment and the direction of these associations are summarised in Table 1.2. Overall, the majority of variables pertaining to accessibility of facilities have been found to be associated with physical activity. Specific opportunities for activity also exhibited significant associations. A relationship between home equipment and physical activity was found for most of the studies that assessed this variable. Few studies examined the relationship between weather and physical activity (Table 1.2). Poor weather was examined as a barrier to physical activity in two studies but neither found a significant association. Few of the studies that used items pertaining to ‘safety’ reported significant associations with physical activity.

Table 1.1: Patterns of Findings on the Associations for Accessibility of Facilities and Opportunities for Activity, with Physical Activity (for the primary source of this Table and the links to the studies cited, see the full paper in Appendix A-1).

Environmental Variable	Studies (citation #)	Associations
Accessibility of Facilities		
A cycle path is accessible	23	+
Busy street to cross	29	-
Busy street to cross ^a	29	0
Negotiate steep hill	29	0
Negotiate steep hill ^a	29	-
Access to facilities (local park)	22	+
Facilities on frequently travelled route	21	+
Density of pay and free facilities ^a	31	+
Neighbourhood residential	29	-
Number of convenient facilities	19/25	0/0
Lack of facilities	15/19	- / -
No facility nearby (women)	16	-
Available facilities inadequate	16	-
Access to built facilities ^a	32	0
Access to natural facilities ^a	32	0
Distance to bikeway	29	-
Distance to bikeway ^a	29	-
Park or beach in walking distance	23	+
Shops are in walking distance	23	+
Opportunities for activity		
Presence of sidewalks	17/21	0 / 0
Home equipment	22/21/19/26/25	0 / + / + / +/0
Lack of equipment	15/19	- / -
Awareness of facilities	24	+
Satisfaction with recreation facilities	20	+
Neighbourhood environment	19/25	0/+
My area offers opportunities for physical activity	28	+
Local clubs and others provide opportunities	28	+
Coastal residence	30	+
Functional environment (footpath/shop)	32	0

^a objectively assessed by Geographic Information System or other objective data

+ significant positive association found with physical activity

- significant negative association found with physical activity

0 no association found with physical activity

Table 1.2: Patterns of Findings on the Associations of Weather, Safety and Aesthetic Factors, with Physical Activity (for primary source of this Table and the links to the studies cited, see the full paper in Appendix A-1).

Environmental Variable	Studies (citation #)	Associations
Weather		
Poor weather	18	0
Lack of good weather	19	0
Safety		
Footpaths are safe	22	+
How safe to walk or jog alone in day	18/22/21	0 / 0 / 0
Lack a safe place to exercise	18/17	0 / 0
High levels of crime	18/17	0 / 0
Unattended dogs	18/17	+ / 0
Streetlights	18/17	0 / 0
How safe from crime is your neighbourhood	27	+
Heavy traffic	18/17	0 / 0
Aesthetics		
Neighbourhood friendly	23	+
Pleasant near home	23	+
Local area is attractive	23	+
Enjoyable scenery	18/17	+ / +
Hills	18/17	+ / 0
Living environment	20	+
Appeal (traffic/trees)	32	0

+ significant positive association found with physical activity

- significant negative association found with physical activity

0 no association found with physical activity

1.4.1 Understanding Environmental factors associated with adults' walking behaviour

The focus of this thesis is on the specific health behaviour of walking. A further updated review focussing specifically on environmental correlates of walking was thus conducted in early 2003. In the two years since the first review of environmental attributes found to be associated with physical activity, a small number of new studies had been published or were 'in press' with peer-reviewed journals. Studies examining relationships of environmental attributes with walking behaviour were identified from the previous literature review (Humpel et al., 2002), from database searches including PsycInfo, Cinahl, Medline, and from papers currently 'in press' with peer-reviewed journals supplied by research colleagues. Studies were included if (1) they used walking as the main outcome variable, whether for exercise, recreation, transport or work; (2) the independent variables included environmental attribute variables, whether measured objectively or by individual perceptions; and (3) if the studies were of adults.

Eleven studies were identified as meeting the criteria. Ten studies were of cross-sectional design, one study was prospective in design. Six studies used measures of environmental perceptions, while seven studies included at least one objective measure of the environment (Table 1.3). This summary of findings includes: the environmental attributes measured, the demographic variables the analysis was statistically adjusted for; the type of walking outcome; and the main findings and their direction.

Studies using objective measures. Berrigan & Troiano (2002) used home age as a proxy measure of urban form (see Table 1.3). They proposed that neighbourhoods comprising of older homes are more likely to have higher housing density, and have a mix of business and residential use. Homes built before 1973 were found to be associated with the owners walking more than 20 times a month for any reason. Other forms of physical activity were not found to be associated with home age. Brownson, Houseman, Brown, Jackson-Thompson, King, Malone, et al. (2000) evaluated the use of a new walking trail. Among people who reported using the trail, 55.2% had increased their amount of walking. Distance to the trail was not associated with walking but this may be due to 43% of respondents having to travel 15 miles or more to the trail. Craig, Brownson, Cragg and Dunn (2002) found that a high neighbourhood environment score (observer rating of neighbourhood characteristics) was significantly related to walking to work and this result was moderated by the degree of urbanization, with higher scores found in urban neighbourhoods compared to suburban neighbourhoods.

Saelens and colleagues (Saelens, et al., in press) found that living in a highly-walkable neighbourhood (as defined by residential density, mixed use, and street connectivity) was associated with participants spending more time than did those living in a low walkable neighbourhood, in walking for errands and on breaks at work or school. This association was not found for walking for exercise or for total walking.

Studies using objective and/or perceived measures. A prospective study examining changes in walking over two years (Hovell, Hofstetter, Sallis, Rauh, & Barrington,

1992) found that the number of convenient facilities reported at baseline was associated with an increase in walking at follow-up, whereas neighborhood environment was not related to change in walking. Two studies using Australian samples (Ball, Bauman et al., 2001; Carnegie et al., 2002) found two environmental domains associated with more walking; an aesthetically pleasing environment (for example, pleasant and attractive) and a convenient or practical environment (for example, shops near, park or beach near). An earlier study by Hovell et al. (1989) found that neighbourhood environment (for example, safety and ease of exercising) was associated with walking for exercise.

Giles-Corti & Donovan (2002b) examined a number of both objective and perceived environmental attributes with walking in a sample from an Australian city. They found associations with walking for transport (see Table 1.3); access to a beach and an attractive, safe and interesting neighbourhood were associated with walking for recreation; access to open spaces and aesthetic neighbourhood perceptions was associated with walking at recommended levels. In a further paper using the same sample (Giles-Corti & Donovan, in press), it was found that a higher score on a composite objective physical environment measure was associated with walking at recommended levels.

Perceptions of the aesthetic nature of the environment have most often been measured with walking behaviour. This attribute has been found to be significantly associated with walking for exercise or recreation in three studies and in two studies with total walking. Convenience of facilities has been found to be associated with walking for exercise or recreation in four studies.

Table 1.3: Characteristics and Main Findings from Studies Examining Relationships of Environmental Attributes With a Main Outcome of Walking

Reference Number	Number/ Age/ Gender	Design	Walking outcome	Environmental variables	Result	Statistical Adjustment
Ball et al (2001)	N=3392 Adult Men=46%	CS,p	For exercise	Aesthetically pleasing environment Convenient environment	Significant (+) Significant (+)	A,G,E
Berrigan et al (2002)	N=14,827 Adults M=48%	CS,o	≥ 20times per month	Age of home	Significant for older home (+)	A,G,E, Eth,I
Brownson et al (2000)	N=1269 Adults Men=34.5%	CS,o	Increased walking since using trail	Walking trail length Trail surface Distance to trail	Significant users of longer trails (+) Significant users of asphalt trails (+) Non-significant	None reported
Carnegie et al (2002)	N=1,200 40-60 years Men=42.6%	CS,p	Total	Aesthetic environment Practical environment	Significant positive perceptions assoc with more walking (+)	A,G,E
Craig et al (2002)	Canadian census 1996	CS,o	To work	Composite environment score	High environment score associated with more walking to work (+)	U,E,I,P
Giles-Corti et al (2002)	N=1803 18-59 years	CS, p,o	For transport For recreation	1 Access to public open space 2 Access to beach 3 N/hood perceptions (aesthetics)	Significant for 1(+), 2(-), 4(+), 5(+), 6(+) Significant for 2(+), 3(+)	A,G,E,I,C,W

		As recommended	4 Perceptions of traffic, busy roads 5 Footpaths available 6 Shops in walking distance	Significant for 1(+), 3(+)
Giles-Corti et al (in press) walking paper	N=1803 18-59 yrs	CS,o As recommended	Composite physical environment score Major traffic, no trees No footpath, no shop	Significant (+) Significant (-) Significant (-) A,G,C,E,I
Hovell et al (1989)	N=194	CS, p For exercise	Home equipment Neighbourhood environment Convenient facilities	Non-significant Significant (+) Non-significant A,G
Hovell et al (1992)	N= 1701 Mean=48 years	Pros,p Change over 2 years	Neighbourhood environment Convenient facilities	Non-significant Significant (+) A,G
Saelens et al (in press)	N =110 mean 48 years men 46.7%	CS, o For errands outside home On work/school breaks For exercise Total walking	High-walkable neighbourhood	Significant (+) Significant (+) Non-significant Non-significant Unadjusted
Sallis et al (1997)	N=110 Men=25% M=20.6 Years	CS,p For exercise	Home equipment Convenient facilities Total neighbourhood	Non-significant Non-significant Non-significant A,G,Eth, SES

o – objectively measured; p – perceptions; CS – cross-sectional; Pros – prospective; A- age; G-gender; E – education; Eth- ethnicity; I – income; P- poverty;
C – number of children; W – work status; U – urbanization; OR – odds ratio; (+) - positive association; (-) - negative association

However, access to beach and access to services could also potentially be categorized as convenient facilities. Access to beach and public open spaces, and shops within walking distance, and having a highly walkable neighbourhood were found significantly related to walking to get to and from places. Perceptions of traffic were found to be positively associated with walking to get to and from places, and traffic volume was negatively associated with walking for exercise or recreation.

Pikora and colleagues (Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003) developed a framework of potential environmental influences on the specific behaviours of walking and cycling for recreation and transport. Based on findings from the health, transport and urban planning literature, four key groupings of variables were identified: functional, safety, aesthetics and destination.

Using the framework of items from the literature as a base, a Delphi study was conducted with panel members identified as experts based on academic and practice expertise. This panel made further suggestions of environmental attributes for inclusion and rated the relative importance of the variables within the framework. Pikora et al. (2003) found that safety, aesthetics and destinations were judged to be the most important attributes for exercise walking, and continuity of the walking surface was judged the most important attribute for transport walking. These ratings by experts of environmental attributes that should be important for physical activity; aesthetics, safety and destination (facilities, services, accessibility), give support to the findings reported from the literature review reported in sections 1.4 and 1.41.

The findings of the above Delphi study were used to develop an environmental audit instrument, the Systematic Pedestrian and Cycling Environmental Scan (SPACES) (Pikora et al., 2002). Data were collected from segments of roads in Perth, Western Australia, by trained observers and reliability testing of the instrument reported generally high inter- and intra- observer ratings. The authors have not yet reported a study using SPACES to identify associations of environmental attributes with walking behaviour.

1.5 Summary and Research Aims

Part 1 has described the importance of physical activity for improving health outcomes, and the prevalence and importance of walking as a health-related behaviour. It has described the theoretical approaches taken to assess and understand the correlates of the physical environment with physical activity and the rationale for studying the particular behaviour of walking. Walking is the ideal way for sedentary adults to engage in habitual physical activity. Walking can be done for exercise, leisure, as part of a person's occupation, as transport to get from place to place or for all of these purposes.

The importance of measuring both perceived and objective environmental attributes was also addressed. In section 1.4, research findings of both perceived and objectively assessed environmental attributes with both physical activity in general and the specific behaviour of walking were reviewed.

In light of the available evidence, it would seem that research on environmental influences shows promise for the purpose of identifying significant and potentially

modifiable influences on physical activity and walking behaviour. While the importance of such influences is becoming evident, the pursuit of creating opportunities to enhance physical activity in the environment must be strengthened by empirical studies.

Prior studies were found to be limited to cross-sectional associations with only one prospective study being found for physical activity (Sallis, Hovell, & Hofstetter, 1992) and one for the specific behaviour of walking (Hovell et al., 1992). This over-reliance on cross-sectional designs has limited the ability to make causal inferences about environmental attributes as a potential influence on physical activity.

Prospective studies of environmental variables as predictors of physical activity change are needed, as are intervention studies, to advance the field so that conclusions can be drawn regarding the possible causal nature of these environment-behaviour relationships. Prospective studies, while still observational studies, provide clearer evidence of a time sequence. Intervention trials on the other hand, can document whether the effect of altering predictor variables has an effect on physical activity behaviours. Such studies have not so far been reported.

A number of the significant findings in the above reviews have reported relationships with vigorous activity, with relatively few findings on moderate-intensity activities or walking. More studies are needed that focus on particular types of moderate-intensity activity such as walking.

Diverse behaviours and environments have been studied so far with diverse methods and items to measure these associations. How best to assess the influence of the environment on adults' participation in walking is still at an early stage. A large range of items attempting to measure similar tentative environmental correlates of physical activity has been used in the literature with little evidence of either reliability or validity reported. There is a need to develop, particularly for perceptions of the environment, reliable and valid scales that can accurately assess this environment-behaviour relationship.

Levels and types of physical activity have been found to differ significantly by gender (USDHHS, 1996). Few studies have reported results separately for men and women and gender-specific correlates of physical activity are poorly understood (Sallis & Owen, 1999). For this reason, gender-specific analyses were conducted throughout this thesis.

This thesis reports one measurement study and four related and complementary studies of environmental factors associated with adults' walking. The broad objectives of this thesis are:

- To develop and test measures of perceptions of environmental attributes
- To examine cross-sectional relationships between perceptions of the environment and walking behaviour
- To examine prospective relationships between environmental perceptions and walking behaviour
- To examine associations for men and women separately

PART 2

RELIABILITY OF MEASURES OF PERCEIVED ENVIRONMENTAL ATTRIBUTES OF WALKING²

2.1 Introduction and Aims

As discussed in Part 1.2.4, there is a lack of measures in the literature on perceptions of the physical environment, and even fewer studies that have reported psychometrics of any items used. Therefore, the aim of this study was to explore the test-retest reliability of items measuring perceptions of physical environment attributes that may be associated with participation in walking (Saelens et al., in press). For a measure to be reliable, there must be consistency of scores from one administration time to the next (Murphy & Davidshofer, 1998).

Following the proposal from ecological models for the development of behaviour-specific models, a second aim of this study was to develop and test a specific neighbourhood walking item. A third aim was to test the reliability of recall of total walking, and a composite physical activity measure from the International Physical Activity Questionnaire (IPAQ). As this study was one of the first to examine reliability of environmental measures, possible differences for men or women in the reporting of environmental perceptions and recall of walking and physical activity were examined.

² The study reported here is included in a paper accepted for publication as Humpel N, Marshall A, Leslie E, Bauman A, & Owen N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*. This paper (in a pre-print format) can be found in Appendix A-3.

In the subsequent studies reported in Part 3 of this thesis, it was planned to categorize these environmental items by logical groupings (as reported in the literature review Part 1.4). In preparation for this, the test-retest reliability was also conducted for the four categories: aesthetics, convenience, access and traffic.

2.2 Methods

2.2.1 Study sample

The sample for this study was drawn from a list of 385 adults working at a regional Australian University. At completion of a previous study, these people had agreed to be contacted again at a future date. Eighty adults were contacted by telephone and asked to participate in the study. The sample was composed of 35 men and 45 women with a mean age of 43 (SD = 11) years.

2.2.2 Design and procedure

As types and amounts of physical activity are highly variable, retest needs to be conducted within the same time period as the first test. That is, if the item asks for recall of activity in the last 7 days, the retest needs to be within the next seven days. At the first testing, participants were asked for permission to telephone them again in two or three days. Time between tests was a mean of 2.44 (SD = 0.78) days. For both interviews participants were asked about the preceding seven days. Approval by the University Ethics Committee had been obtained for the study.

2.2.3 Study measures

Perceived environmental attributes. Neighbourhood environment attribute items were based on findings from the literature review of studies that assessed relationships between environment attributes and physical activity behaviours (Humpel et al., 2002). The final items selected for inclusion in this study are supported by an earlier Australian study (Ball, Bauman et al., 2001) that found significant associations between categories of ‘aesthetics’ and ‘convenience’ and walking. That study reported a confirmatory model which showed that all items loaded satisfactorily on these two constructs (explaining 36-64% and 10-60% of the variance respectively).

Participants were asked eight items about aspects of their neighbourhood that might influence whether or not they walked. There were two items that specifically assessed the generally-positive nature of the local physical and social environment (aesthetics). These were “How would you rate the general friendliness of the people?” and “How enjoyable is the scenery?”

Three items specifically asked about the convenience of walking opportunities in the neighbourhood (convenience): “How would you rate the walking distance to park or beach?”; “How accessible is a path or cycleway for walking?” and “Overall, how convenient is it to walk in your neighbourhood?”.

Two items assessed access to services (access): “How would you rate the walking distance to shops?” and “How would you rate the walking distance to a bus stop or train station”.

One item asked, “How much of a problem is traffic when walking in your neighbourhood?” (traffic). As the method of administering this survey was telephone interview, a 1-10 rating scale was used. The anchors for each item were matched to the wording of each item (for example, “on a scale of 1-10 where 1 is not at all friendly and 10 is very friendly”). Each item was tested individually for reliability. Items were also summed to provide a total category scores for ‘aesthetics’; ‘convenience’; ‘access’ and ‘traffic’ and these categories were tested for reliability.

Physical activity behaviour. The specific neighbourhood walking item asked participants: “How many times a week do you go for a walk for any reason (for example, for exercise, doing errands, walking for transport) in and around your neighbourhood?” and “How much time would you usually spend when you do go for a walk in and around your neighbourhood?” (in minutes). Physical activity was also measured by the International Physical Activity Questionnaire (IPAQ). This instrument includes a measure of total walking. The activity types measured by the IPAQ (total walking, moderate activity and vigorous activity) were summed to gain an overall estimate of the total physical activity performed in a week (min/week). These three physical activity measures were examined for test-retest reliability. A complete copy of the survey is included in Appendix B-1.

2.2.4 Methods of analysis

The test-retest reliability between the first and second administration of both the environmental perceptions and the walking items was assessed using Spearman's correlation coefficients and Intraclass correlations (ICC). The ICC method was chosen as the variables were continuous and the measure takes into account the level of agreement that could have occurred by chance. ICC can report consistency or absolute agreement between tests; the stricter measure of absolute agreement was chosen for all analyses. Spearman's statistic was chosen as a secondary confirmation procedure.

A potential problem in test-retest studies is that many participants may report no activity during the period in question. These identical zero values for Time 1 and Time 2 testing may potentially inflate the measure of reliability. As 23% of participants at Time 1 and 21 % at Time 2 reported zero neighbourhood walking minutes, analysis was re-run for this item excluding these participants.

2.3 Results

2.3.1 Test-retest reliability for measures of perceptions of the environment

The ICC's and 95% confidence intervals (95% CI) for each of the perceived environmental attribute items are presented in Table 2.1. For the total sample, ICC's for all items were above 0.73, which can be described as excellent reliability. Some

environmental items showed a lower reliability for men’s perceptions, however these results were still good.

Table 2.1: Intra-class Correlations and 95% Confidence Intervals for Perceived Environmental Attribute Items for the Total Sample and for Men and Women Separately.

	Total Sample N=80	Men N=35	Women N=45
Neighbourhood friendly	0.91 (0.86-0.94)	0.84 (0.71-0.29)	0.93 (0.88-0.96)
Enjoyable scenery	0.89 (0.84-0.93)	0.83 (0.69-0.91)	0.93 (0.87-0.96)
Distance to park/beach	0.75 (0.64-0.83)	0.68 (0.46-0.83)	0.79 (0.64-0.88)
Overall convenience	0.75 (0.63-0.83)	0.62 (0.36-0.79)	0.81 (0.67-0.89)
Access to cycleway/path	0.81 (0.72-0.87)	0.69 (0.46-0.83)	0.90 (0.82-0.94)
Distance to shops	0.88 (0.82-0.92)	0.88 (0.78-0.94)	0.87 (0.80-0.94)
Distance to bus or train stop	0.79 (0.69-0.86)	0.72 (0.51-0.85)	0.82 (0.70-0.90)
Traffic as a problem	0.73 (0.60-0.82)	0.66 (0.43-0.81)	0.77 (0.61-0.87)

Table 2.2: Intra-class Correlations and 95% Confidence Intervals for Environmental Perceptions Categories for the Total Sample and Men and Women Separately.

	Total sample	Men	Women
Aesthetics	0.93 (0.90-0.96)	0.90 (0.81-0.95)	0.95 (0.91-0.97)
Convenience	0.86 (0.79-0.91)	0.81 (0.65-0.90)	0.89 (0.80-0.94)
Access to services	0.86 (0.79-0.91)	0.84 (0.70-0.91)	0.87 (0.77-0.93)
Traffic as a problem	0.73 (0.60-0.82)	0.66 (0.43-0.81)	0.77 (0.62-0.87)

The ICC results for each perceived environmental category for the total sample and separately for men and women are presented in Table 2.2. For ‘aesthetics’, ‘convenience’ and ‘access to services’ excellent agreement was found for both men and women. As ‘traffic’ was only one item, these results are a replication of the individual item.

2.3.2 Test-retest reliability for measures of walking and physical activity

Three physical activity measures were also tested for reliability; neighbourhood walking, total walking and total physical activity (see Table 2.3). The specific neighbourhood walking item was found to have excellent agreement between testings. The ICC and 95% CI’s for the total sample were, 0.92 (0.88-0.95), for men 0.82 (0.67-

0.91) and for women 0.95 (0.90-0.97). When analysis was re-run excluding those participants with zero minutes of neighbourhood walking at time 1 and 2, ICC's remained high for the total sample and both men and women (total sample = 0.92 (0.87-0.95)).

Total walking as measured by the IPAQ item also reported excellent agreement between testings. The ICC's and 95% CI's for the total sample were 0.94 (0.91-0.96), for men 0.98 (0.96-0.99) and for women 0.74 (0.57-0.85).

Total physical activity, the sum of total walking, moderate activity and vigorous activity as measured by IPAQ items found ICC's and 95% CI's for the total sample to be 0.85 (0.78-0.90), for men 0.92 (0.84-0.96) and for women 0.72 (0.54-0.83).

As the data were found to be skewed, the non-parametric Spearman's correlation coefficient was performed on all perceived environment items and all physical activity items (statistical results not reported). Similar results to the ICC's were found for all items.

Table 2.3: Intra-class Correlations and 95% Confidence Intervals for the Total Minutes per Week for each Physical Activity Measure.

	Total sample	Men	Women
Neighbourhood walking	0.92 (0.88-.95)	0.82 (0.67-.91)	0.95 (0.90-.97)
IPAQ total walking	0.94 (0.91-.96)	0.98 (0.96-.99)	0.74 (0.57-.85)
IPAQ total moderate PA	0.74 (0.62-.82)	0.62 (0.37-.79)	0.78 (0.63-.87)
IPAQ total vigorous PA	0.65 (0.50-.76)	0.59 (0.33-.77)	0.88 (0.79-.93)
Total physical activity	0.85 (0.78-.90)	0.92 (0.84-.96)	0.72 (0.54-.83)

IPAQ – International Physical Activity Questionnaire; PA – physical activity

2.4 Summary

The results strongly support the test-retest reliability of the perceived environmental attribute items and the hypothetical ‘groupings’ of the items into categories. This provides early confidence in the reproducibility of the measures of these ‘constructs’ of environmental influence on walking behaviour.

The item measuring the particular behaviour of neighbourhood walking also evidenced strong test-retest reliability across testings. Most participants were able to recall the frequency and duration of time spent walking in the neighbourhood with good accuracy. This indicates that any change observed over time could be interpreted as real

changes in both environmental perceptions and behaviour. This study supports findings from a previous study examining the reliability of neighbourhood environment items (Saelens et al., in press), which also found a good ICC for 'aesthetics' (including tree cover, attractive sights) of .79. The sub-scale of 'walking/ cycling facilities' (including sidewalks, bike trails) reported an ICC of .58.

2.5 Limitations of the study

A limitation of this reliability study was the short time span of two to three days between testings for the environmental perception items. It is possible the participants may have recalled at retest what they said at the first test time. This short time span was required because the high variability of physical activity levels makes it necessary to retest within the same recall period of the first test. A longer between test period may have resulted in different findings. A second limitation of the study was the non-random method of sampling from the list of potential participants, which may have led to selection bias.

PART 3

CROSS-SECTIONAL AND PROSPECTIVE ASSOCIATIONS OF ENVIRONMENTAL ATTRIBUTES WITH WALKING: WORKPLACE SAMPLE³

3.1 Introduction

Part 1.3.3 discussed ecological models of health behaviour, which provide a broad account of multiple levels of influence with a particular focus on environmental factors (Dzewaltowski, 1997; Sallis & Owen, 2002; Spence & Lee, 2003). When attempting to understand a specific health behaviour, a more specific model is needed (Sallis & Owen, 1997, 2002). This applies particularly to physical activity as there are many types of activity and they can all be performed in different settings and contexts. The studies reported in Part 3 thus focus on the specific behaviour of neighbourhood walking. Also consistent with ecological models (Owen et al., 2000; Sallis & Owen, 2002), environmental correlates are expected to be setting-specific (Richard et al., 1996). Thus, neighbourhood environment attributes ought to be more-strongly related to walking in the neighbourhood than to more general indices of activity.

Parts 3.2 and 3.3 report a cross-sectional study examining the associations between the perceived neighbourhood environmental attributes described in Part 2.2, with walking

³ The studies reported in Part 3 have been accepted for publication as Humpel N, Owen N, Leslie E, Marshall A, Bauman A, & Sallis JF. (in press). Associations of location and perceived environmental attributes with walking in neighborhoods. *American Journal of Health Promotion.*; and, as Humpel N, Marshall A, Leslie E, Bauman A, & Owen N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*. These papers (in a pre-print format) are in Appendix A-2 and A-3.

specific to the neighbourhood, and also the more inclusive activity of total walking (including neighbourhood walking) and total physical activity as reported by participants. While a person's perceptions about the local environment are important, it is also important to use variables that can be objectively measured. The studies reported in Part 3 also include a broad objective measure of environment, location by postal code.

Parts 3.4 and 3.5 report a study that prospectively examines the relationship between changes in perceptions of the environment and changes in walking behaviour. Cross-sectional studies are not able to assess or predict change in important variables.

Measuring variables repeatedly using a longitudinal design enables any change in possible predictor variables to be associated with any change in physical activity behaviour. People's perceptions of their neighbourhood environment may change over time, and their walking behaviour may also change over time.

For the context of the studies of Part 3, refer to page xvii. The context of the intervention trial was not designed to change perceptions of the environment. It was specifically testing the efficacy of the website to increase physical activity behaviour (Marshall et al., in press).

3.2 Cross-Sectional Study of Associations of Environmental Attributes with Walking Behaviour: Hypotheses and Methods

The findings from previous studies reported in the literature (Part 1.4 and 1.4.1; Humpel et al., 2002) informed the choice of environmental attributes that are tested in

the following study. The overall aim of the cross-sectional study was to explore relationships of perceptions of the neighbourhood environment and 'location' of residence with neighbourhood walking, and the more-inclusive summary activity measures of total walking (including neighbourhood walking) and total physical activity (all walking, moderate and vigorous activity).

The hypotheses for the cross-sectional study were:

1. Participants living in a coastal place of residence will have higher rates of walking participation than do those living in a non-coastal place of residence
2. Positive perceptions of environmental attributes will be significantly associated with greater walking participation
3. Perceptions of the neighbourhood environment will demonstrate a stronger relationship with neighbourhood walking compared to more general indices of activity

3.2.1 Study sample and procedure

The population for the study was all staff at a medium sized Australian university who had access to e-mail and a telephone. All staff listed on the electronic directory ($n = 1744$) were sent an e-mail that notified them of the telephone survey. Following the e-mail, 335 staff were excluded from the contact sample (there were five formal withdrawals; 330 were either no longer a staff member, e-mail address failed, or they were on extended leave). The eligible sample included 1409 potential respondents. Of those who were called, 294 (21%) refused to participate, and 315 (22%) could not be

contacted during the survey period. A final sample of 800 (57%) completed the baseline survey.

3.2.2 Measures

All items on environmental attributes, location and walking behaviour were identical in the baseline survey and the follow-up survey. A complete copy of the baseline survey is included in Appendix B-2.

Physical activity behaviour. Physical activity was assessed using the short form of the International Physical Activity Questionnaire (IPAQ). This instrument distinguishes vigorous-intensity, moderate-intensity and walking activity separately in terms of frequency (days/week) and duration (min/day) of each activity category in the past seven days. These activity categories may be treated separately or summed to gain an overall estimate of the total physical activity performed in a week (min/week). The IPAQ has been designed and tested by the International Consensus Group on Physical Activity Measurement (Craig et al., in press).

Neighbourhood walking. Consistent with the case for behaviour specific and context-specific measurement (Bauman et al., 2002; Owen et al., 2000; Sallis & Owen, 2002), the physical activity behaviour of neighbourhood walking was separately assessed. Participants were asked: “How many times a week do you go for a walk for any reason (e.g., for exercise, doing errands, walking for transport) in and around your neighbourhood?” and “How much time would you usually spend when you do go for a walk in and around your neighbourhood?” The frequency of walking was multiplied by

the number of minutes for each time to give a total number of minutes of neighbourhood walking each week. The test-retest reliability of this item was satisfactory (ICC = 0.92) and is reported in Part 2.3.2.

Location by postal code. A previous Australian study (Bauman et al., 1999) found that in locations where the postal code touches the coastline, physical activity is higher, even when adjusted for socio-economic status. Thus an item asking participants for their postal code at home was included. In Australia, a postal code district is a mail delivery area identified by four digits, used functionally in the same way as are zip codes in the USA. Each postcode generally covers one or more adjacent named suburbs in urban areas. No data on population numbers at postcode level are available. A structured query language (SQL) function used Australian Bureau of Statistics 1996 Census data to identify postal areas that intersect the coastline. This variable was coded into non-coastal (30%) and coastal (70%) location.

Perceived environment attributes. Neighbourhood environment attribute items were based on findings from the review of studies that assessed relationships between environment attributes and physical activity behaviours (Humpel et al., 2002) which was reported in Part 1.4. Items that were found to have the strongest associations with physical activity behaviour were adapted for the study. The eight selected items were preceded by the statement, “The following questions will ask you to rate aspects of your home neighbourhood that might influence whether or not you walk”. As the method of administering this survey was telephone interview, a 1-10 rating scale was used. The anchors for each item were matched to the wording of each item (for

example, “on a scale of 1-10 where 1 is not at all friendly and 10 is very friendly”). For a greater description and the reliability of the items, see Part 2.2.

3.2.3 Method of analyses

All analyses were conducted using Statistical Package for the Social Sciences (SPSS) v11.0. Preliminary analysis showed the data to be strongly negatively skewed. Therefore, logistic regression was used in order to deal with the data in a categorical form. For these analyses, summed scores of ‘aesthetics’, ‘convenience’, ‘access’ to services and ‘traffic’ as a problem were transformed into categorical variables with three levels; low (a less positive perception of the environment), moderate, and high (a highly positive perception of the environment). The cut-off points used for these levels were those that most closely approximated the tertiles of the distributions. To facilitate comparison of environmental perception categories in Table 3.2, each summed category score was divided by the number of items contained in that category, to give a score ranging from 0 to 10. A significance level of 0.05 was set for all analysis.

A series of logistic regression models were used to examine the association between ‘location’ and the perceived environmental categories, and the three outcome variables: neighbourhood walking; total walking (the IPAQ walking item which incorporates neighbourhood walking); and, total physical activity (sum of IPAQ walking, moderate-intensity activity and vigorous activity items, with vigorous activities given a weighting of two). All models controlled for age and education. Several past studies have found that physical activity differs for men and women (Sallis & Owen, 1999; USDHHS, 1996) resulting in an aim of this thesis being to conduct all analyses separately for men

and women. Each outcome variable was dichotomised at the median score. All four physical environment attribute variable categories, ‘location’ plus age and education, were entered simultaneously into the model.

3.3 Cross-sectional Associations of Environmental Attributes with Walking Behaviour: Outcomes

3.3.1 Characteristics of the participants

A final sample of 800 completed the baseline survey, which included 398 (49.8%) women and 402 (50.3%) men. Characteristics of the participants are in Table 3.1. Ages ranged from 18 to 71 years with a mean age of 43 years. Full-time workers made up 83% of the sample. Academic (faculty) staff members were 53%, and general staff were 43% of the total sample (4% did not identify their job classification). At the time of this study, total staff at the University consisted of 43% academic, 57% general, with 62% being female.

3.3.2 Perceptions of the environment with walking

Overall, high scores were observed across all the environment items, ranging from $M = 6.4$, $SD = 2.8$ for ‘distance to shops’ to $M = 8.0$, $SD = 2.3$ for ‘convenient to walk’. The mean minutes of neighbourhood walking, total walking and total physical activity, and the mean scores for perceived environment categories are presented separately for men and women in Table 3.2. The differences in mean minutes of walking and total physical activity for men and women were non-significant.

Table 3.1: Characteristics of Participants and Distribution by Location

	Men		Women	
	%	N	%	N
Gender	49.8	398	50.3	402
Age				
18-29	10.9	43	11.6	46
30-39	18.5	73	25.8	102
40-49	36.5	144	40.4	160
50-59	28.1	111	18.7	74
60+	6.1	24	3.5	14
Education				
12 years or less	11.6	46	19.5	77
TAFE/Diploma	9.3	37	16.2	64
Tertiary	79.0	313	64.3	254
Location				
Coastal	69.0	275	70.8	284
Non-coastal	30.9	123	29.2	117

Table 3.2: Mean Minutes and Standard Deviations for Physical Activity Behaviours, and Mean Scores on Perceived Environmental Attribute Categories.

	Men		Women	
	Mean	SD	Mean	SD
Physical Activity				
Neighbourhood walking	110	148	109	111
Total walking	255	385	278	408
Total physical activity	557	618	538	567
Environment categories				
Perceived Aesthetics	7.5	1.7	8.0	1.6
Perceived Convenience	7.2	3.2	7.3	2.3
Perceived Access	6.7	2.2	7.3	2.3
Perceived Traffic	7.6	1.2	7.7	1.2

Perception of the environment for ‘access’ to services among women ($M = 7.3$) was significantly more positive than was the mean score for men ($M = 6.7$), $F(1,797) = 10.04$, $p < .002$. There were also significant age differences for ‘access’ $F(4,785) = 11.05$, $p < .001$. A post hoc Scheffe test found that those in the three age categories up to 49 years of age (18-29, $M = 7.6$; 30-39, $M = 7.5$; 40-49, $M = 7.1$) had more positive perceptions of ‘access’ to services than those in the two age categories over 50 years (50-59, $M = 6.2$; 60+, $M = 6.2$). There was no association of educational attainment with perceived ‘aesthetic’ nature of the environment or ‘access’ to services. The environmental categories of ‘convenience’ and ‘traffic’ did not show any statistically significant differences by age, gender or educational attainment.

3.3.3 Place of residence

Significant differences in mean minutes of neighbourhood walking were observed for location by postal code, $F(1,797) = 6.12$, $p < .01$. Participants with a coastal place of residence ($M = 117$ mins.) walked significantly more in their neighbourhood than did non-coastal residents ($M = 92$ mins.). When examining men and women separately, coastal men’s ($M = 119$ mins) minutes of neighbourhood walking was not significantly more than non-coastal men ($M = 94$ mins; $F(1,396) = 2.42$, $p = .12$). However, coastal women did walk significantly more in the neighbourhood ($M = 116$ mins) compared to non-coastal women ($M = 91$ mins; $F(1,399) = 4.21$, $p < .04$). ‘Location’ differences for the other two outcomes variables were non-significant. Thus the results partially supported *Hypothesis 1* that participants living in a coastal place of residence will have higher rates of walking participation. Participants living in a coastal place of residence participated in more neighbourhood walking than those living in a non-coastal

residence, but there was no difference by location for total walking or total physical activity.

Coastal residents scored higher than did non-coastal residents on ‘convenience’ of the environment, $F(1,790) = 6.24$, $p < .013$ ($M = 7.4$ and $M = 7.0$ respectively), and on their ratings of the ‘access’ to services for walking, $F(1,796) = 5.13$, $p < .024$ ($M = 7.1$ coastal compared to $M = 6.7$ non-coastal). Differences between ‘location’ mean scores for ‘aesthetics’ and ‘traffic’ as a problem were not significant.

3.3.4 Multivariate analyses: predictors of walking outcomes

Only one significant result emerged for total physical activity. Those men who had the highest scores for ‘convenience’ were 1.82 times more likely to have high participation in total physical activity (Table 3.3).

For total walking among men, ‘access’ to services was the only physical environment category found to be associated. Compared to those men with low scores, those with high scores on ‘access’ to services were 2.09 times more likely to report high total walking.

The objective physical environment variable ‘location’ was significantly associated with neighbourhood walking for men independent of the perceived environmental attribute variables. Men living in a coastal location were 1.66 times more likely to be in the high neighbourhood walkers (Table 3.3). Among men, there were strong positive associations of the ‘aesthetics’ and ‘convenient’ and ‘access’ environment categories

for neighbourhood walking. Those with a moderate 'aesthetics' score were 1.77 times more likely, and those with the highest scores of 'aesthetics' were 1.91 times more likely to report a higher level of neighbourhood walking. Those with the highest scores on 'convenient' environment category were 2.20 times more likely, to report high neighbourhood walking participation. A high 'access' score was associated with men being 1.98 times more likely to be in the high neighbourhood walkers. Interestingly, a significant negative relationship emerged with men for 'traffic' as a problem. Those in the highest level (traffic is not a problem) were 55% less likely ($OR = 0.45$) to report high neighbourhood walking.

No associations were observed among women for the 'location' or perceived environment variables with total physical activity (Table 3.3). Those women with moderate scores for 'access' to services were 1.92 times more likely to have high participation in total walking.

For women, those with a moderate 'convenience' score were 3.19 times, and those with a high score were 3.78 times more likely, to have a higher level of participation in neighbourhood walking. A significant negative association for 'access' to services with neighbourhood walking emerged for women. A high score for the 'access' environment variable resulted in women being 52% less likely to be high neighbourhood walkers ($OR = 0.48$). The variable 'location' did not evidence any association among women.

Table 3.3: Logistic Regression Model Stratified by Gender: Odds Ratios and 95%CI for Location and each Category of Environmental Variables and the Likelihood of being in the Higher Category of Participation for Neighbourhood Walking, Total Walking and Total Physical Activity.

	Men			Women		
	Neighbourhood walking	Total walking	Total physical activity	Neighbourhood walking	Total walking	Total physical activity
Location						
Non-coast	1.00	1.00	1.00	1.00	1.00	1.00
Coast	1.66 (1.04-2.67)*	1.01 (0.64-1.59)	1.12 (0.70-1.76)	0.99 (0.62-1.58)	1.00 (0.63-1.58)	0.99 (0.63-1.57)
Aesthetics						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.77 (1.06-2.97)*	1.29 (0.77-2.14)	1.10 (0.66-1.84)	1.40 (0.79-2.46)	1.15 (0.66-2.01)	0.78 (0.45-1.36)
High	1.91 (1.08-3.37)*	1.69 (0.97-2.94)	1.56 (0.89-2.73)	1.30 (0.71-2.36)	1.44 (0.79-2.60)	1.25 (0.69-2.24)
Convenience						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.34 (0.80-2.24)	1.09 (0.65-1.80)	0.97 (0.58-1.61)	3.19 (1.81-5.59)***	1.51 (0.87-2.60)	1.24 (0.72-2.12)
High	2.20 (1.21-3.99)**	1.37 (0.77-2.43)	1.82 (1.02-3.24)*	3.78 (2.12-6.73)***	1.37 (0.79-2.38)	1.12 (0.65-1.93)
Access						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.63 (0.97-2.74)	1.57 (0.94-2.63)	0.87 (0.52-1.46)	0.62 (0.34-1.10)	1.92 (1.10-3.37)*	1.25 (0.71-2.17)
High	1.98 (1.12-3.49)*	2.09 (1.20-3.64)**	1.55 (0.89-2.69)	0.48 (0.27-0.87)*	1.12 (0.63-1.98)	1.24 (0.70-2.19)
Traffic						
Big problem	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.94 (0.56-1.56)	0.68 (0.41-1.12)	0.77 (0.47-1.28)	0.81 (0.48-1.36)	0.95 (0.57-1.58)	0.79 (0.47-1.31)
No problem	0.45 (0.25-0.81)**	0.79 (0.46-1.37)	0.77 (0.44-1.33)	0.95 (0.54-1.65)	1.04 (0.60-1.79)	0.90 (0.52-1.55)

* p<.05 ** p<.01 *** p<.001

Overall, of the three physical activity outcomes, the strongest relationships were exhibited with the specific behaviour of neighbourhood walking and for male participants.

These results support *Hypothesis 2*, in that the most positive perceptions of environmental attributes were found to be significantly associated with greater walking participation. *Hypothesis 3* was also supported. Perceptions of the neighbourhood environment were more strongly related to neighbourhood walking compared the more general indices of activity of total walking and total physical activity.

3.3.5 Summary of the findings of the cross-sectional study

The cross-sectional study reported in Parts 3.2 and 3.3 examined associations of objectively determined place of residence and perceived environmental attributes, with neighbourhood walking and with two summary physical activity outcome measures. In bivariate analyses, coastal residents reported significantly more minutes of neighbourhood walking and higher scores for perceived environmental categories. This result adds support to the findings of Bauman and colleagues (Bauman et al., 1999) that coastal residents are more active. Coastal place of residence was associated with higher ratings for ‘convenient’ and ‘access’ environmental attributes; ‘aesthetics’ showed a non-significant trend.

In multivariate analysis, men living in a location where their postcode abutted the coastline walked in the neighbourhood significantly more minutes per week than

those who did not. These findings suggest a possible explanation for the coastal effect. For men, living on the coast may be more influential than for women. The coastal effect was significant with the other perceived environmental variables in the model.

The strength of the associations in this study was notable. For men, three of the five environmental variables were associated with odds ratios near to 2.0. This suggests a population-wide association with environment features that is substantial. Although correlates for women were less consistent, those with high 'convenience' scores were almost four times as likely to be high neighbourhood walkers. The more specific measure of physical activity behaviour (neighbourhood walking) was found to exhibit the strongest relationships with physical environment attributes, as has been proposed by ecological models (Owen et al., 2000; Sallis & Owen, 1997, 2002). Different aspects of the physical environment may influence each type of activity behaviour. By focusing in on a particular behaviour, a clearer picture emerged of the environment-physical activity connection.

These findings also highlight the importance of examining gender-specific associations for both perceived and objective measures of the physical environment. In this cross-sectional study more significant associations were found for men than for women. This study provides some preliminary evidence of specific physical environment attributes, both perceived and objective, that are significant correlates of walking.

As was reported in Part 1.4, a majority of studies examining relationships between environmental attributes and physical activity have been cross-sectional in design. The use of this type of study is necessary in early exploratory studies, such as the field of environmental influences on physical activity, when the aim is to identify and establish links between the variables. However, to begin to build evidence for possible causal relationships, prospective studies are needed. To date, only one prospective study has examined environmental attribute variables with physical activity in general (Sallis et al., 1992), and one has examined relationships with the specific behaviour of walking (Hovell et al., 1992). Prospective design is more powerful because it allows the use of a variable measured at baseline to predict a behaviour that occurs at a later time. Such analyses must be conducted to further our understanding of the influence of environmental attributes on physical activity.

The cross-sectional data from the baseline survey reported evidence of substantial links between the perceived environmental attributes and the objective measure of location of residence with neighbourhood walking. In the following sections (3.4 to 3.5), these relationships were examined prospectively.

3.4 Prospective Study of Associations of Changes in Environmental

Perceptions with Changes in Walking: Hypotheses and Methods

Part 3 sections 3.2 and 3.3 describe the attributes of the participants, the baseline measures and the procedure of the study. Here additional information is provided, relevant to the prospective study described in the following sections. In a prospective study (Sallis, Hovell, Hofstetter, & Barrington, 1992), *change* in social learning

variables was found to show a stronger relationship with *change* in vigorous exercise over two years than did the baseline levels. A study tracking physical activity and psychosocial determinants over seven years (DeBourdeauhuij, Sallis, & Vandelanotte, 2002) found that *change* in psychosocial variables predicted more variance in physical activity for both men and women than the static baseline measures. These authors reported a shortcoming of their study as not including perceived physical environment variables. Hovell et al. (1992) found that the number of convenient facilities reported at baseline was significantly associated with a positive *change* in walking over two years.

This prospective study examines whether perceptions of environmental attributes changed over time, and whether any changes in perceptions reported by participants were related to changes in their walking. As this was arguably the first prospective study examining *changes* in environmental perceptions, the study hypotheses were exploratory and based on findings from the literature.

The hypotheses for the prospective study were:

1. At follow-up, a change in perceptions of the environment will be associated with a subsequent change in walking behaviour
2. At follow-up, participants living in a coastal location will not have increased their walking significantly more than those in a non-coastal location (because they are already more active)
3. The strength of the association between changes in environmental perceptions and walking will lessen as more stringent outcome (greater increase in walking) criteria are used

3.4.1 Characteristics of participants

Follow-up data were collected 10 weeks later from 512 participants (64% response rate) who completed the follow-up telephone survey (mean age of 44 years; 49% men). Those who took part in both the baseline and follow-up survey were not different to the original sample on demographic variables, reported walking, or overall physical activity levels.

3.4.2 Measures

The environmental attribute and neighbourhood walking measures used in the follow-up survey were the same as those used in the baseline study. Additional items were used to measure the impact of the intervention. A complete copy of the follow-up survey has been included in Appendix B-3

Dose of intervention. An additional variable ‘dose of intervention’ was computed when examining the prospective data in order to measure the possible influence of the intervention on neighbourhood walking. Additional items included in the follow-up survey were used to determine how much of the intervention was recalled. These items asked about how many letters or e-mails were received by the participants and how many they had read. They were also asked how much of the booklets they read (print group) and how many times they visited the website (website group).

Whilst the intervention was not designed to influence perceptions of the environment, to control for any potential effects, data pertaining to receipt and use of the

intervention were included as the co-variate ‘dose’ in the analyses. The dose of intervention variable was computed by dividing the number of letters or e-mails received by the number read. To this figure, was added the number of booklets read, or times the website was visited. The ‘dose’ variable was then split at the median, to create a ‘high’ and ‘low’ dose of intervention as a dichotomous variable.

3.4.3 Method of analyses

In the follow-up analyses, in order to control for the effect of baseline levels of perceptions of the environment, which has been found in previous studies to be significantly associated with being more active (Humpel et al., 2002), a *relative change* variable (proportional change scores) was constructed for each of the four categories of perceived environment. This was computed by subtracting the follow-up scores from the baseline scores and then dividing by the baseline score, to give a proportional index of change relative to baseline perceptions.

Prospective analyses were focussed on any associations found for changes in neighbourhood walking. A series of logistic regression models were used to examine the associations of ‘location’ and the relative change in perceived environmental categories with three outcome variables: any increase in neighbourhood walking; an increase of 30 minutes or more; and, an increase of 60 minutes or more. Given the range of measurement error associated with self-report of physical activity (Sallis & Saelens, 2000), stringent criteria for change (minimum increases of 30 minutes and 60 minutes of walking in addition to any increase in walking) were chosen. Age, education and ‘dose’ of intervention were included in all models.

3.5 Prospective Relationships of Changes in Perceptions of Environmental Attributes with Changes in Walking Behaviour: Outcomes

3.5.1 Changes in environmental perceptions and changes in walking behaviour

For men, there was a non-significant decrease in mean minutes of walking from baseline to follow-up. Women reported a non-significant increase in mean minutes of walking (see Table 3.4). Forty percent of men, and 40.8% of women reported an increase of 30 minutes or more of neighbourhood walking. Of these, 33.3% of men and 33.1% of women reported an increase in walking of more than 60 minutes.

Women reported slightly more positive perceptions of the environment than did men, although few of the differences were statistically significant (see Table 3.4; a low score is a less positive perception for that environmental category; a high score is a more positive perception for that environmental category).

Specifically, women's perception of the 'aesthetics' and 'access' to services environmental attributes were significantly higher than those reported by men (Table 3.4). However, at the follow-up no significant differences were apparent between the genders. The percentages of participants who increased scores on perceptions of the neighbourhood environment are reported in Table 3.4.

Table 3.4: Baseline and Follow-up Neighbourhood Walking (minutes/week) and Perceptions Scores for Environmental Attributes for Men and Women.

	Men				Women			
	Baseline		Follow-up		Baseline		Follow-up	
	M	SD	M	SD	#	M	SD	#
Minutes of walking								
Overall	111	157	107	197		107	112	140
Non-coastal residents	94	122	121	115		96	106	125
Coastal residents	119	170	100	111		112	115	147
Environment categories								
Perceived aesthetics	7.56	1.64	7.98**	1.61	54.3	8.05*	1.59	45.1
Perceived convenience	7.16	2.20	7.48	2.05	50.4	7.20	2.25	56.5
Perceived access to services	6.64	2.30	7.07**	2.29	53.4	7.16*	2.36	45.8
Perceived traffic	7.58	2.41	7.93	2.40	45.6	7.71	2.48	43.5

* significantly different mean scores between genders

** significantly different mean scores from baseline to follow-up

percentage of participants who reported improved perceptions

There was no evidence of a relationship between ‘dose’ of intervention and changes in neighbourhood walking. Non-significant findings for ‘dose’ were also evidenced for changes in the four environmental perception categories. Furthermore, the effect of ‘dose’ was non-significant in all logistic regression analyses.

3.5.2 Multivariate analyses: predictors of walking behaviour

Logistic regression models were used to examine whether an increase in perceptions of the neighbourhood environment over time was associated with the three specific increase in walking outcomes. For men, all three outcome variables exhibited strong associations with one or more of the environmental categories (see Table 3.5). Men who improved their perception of ‘aesthetics’ were 2.25 times more likely to have increased walking and twice as likely to have increased walking more than 30 minutes compared to men who did not favourably change their perceptions of ‘aesthetics’. The same trend was evident for increased walking of 60 minutes or more, but was not statistically significant. The pattern of results was similar for perceptions of ‘convenience’.

Men reporting an improved perception of ‘convenience’ had almost twice the likelihood of increasing their walking across all three outcome categories. An increase in perceived ‘access’ to services, however, did not show the same trend. Men who perceived ‘traffic’ as being less of a problem were found to be *less* likely to have increased their participation in walking across all three outcome variables. These results support *Hypothesis 1* for men; that a change in perceptions of the environment would be associated with a change in reported walking. Those men participants who

changed their perceptions (became more positive about their neighbourhood environment) were found to have increased their level of neighbourhood walking.

Men who were coastal residents were less likely to have increased their walking, but this result was only significant for an increase in walking of 60 minutes or more. This result supports *Hypothesis 2* for men only; that is, those men living a coastal location would be less likely to increase their level of walking. As the men living in a coastal location were more active at baseline, this left less room for improvement. At the stringent criteria of 60 minutes or more of increase, the negative relationship became significant.

For women, an improved perception of ‘convenience’ showed the strongest association with an increase in walking (Table 3.5). Women whose perceptions about ‘convenience’ became more positive were twice as likely to report an increase in their walking levels (across all three categories) compared to those with who did not positively change perceptions of ‘convenience’. Increases in perception that ‘traffic’ was not a problem were significantly associated with women being 1.76 times more likely to have an increase in walking of 30 minutes or more. *Hypothesis 1* stated that at follow-up, a change in perceptions of the environment would be associated with a change in walking behaviour. These results support *Hypothesis 1* for women, but to a lesser degree than for men. Changes in perceptions of ‘convenience’ and ‘traffic’ as a problem were found to be associated with changes in walking. Those women who changed their perceptions (became more positive about their neighbourhood environment) were found to have increased their level of walking.

Table 3.5: Odds Ratios (95%CI) for Changes in Perceptions of Neighbourhood Environmental Attributes and Their Association with an Increase in Walking Behaviour Among Men and Women

	Men			Women		
	Any increase in walking	Increase of 30 minutes or more	Increase of 60 minutes or more	Any increase in walking	Increase of 30 minutes or more	Increase of 60 minutes or more
Change in perception of aesthetics						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	2.25** (1.24-4.05)	2.06* (1.12-3.79)	1.82 (0.97-3.38)	1.74 (0.99-3.06)	1.30 (0.73-2.30)	1.09 (0.60-1.97)
Change in perception of convenience						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.95* (1.10-3.45)	2.02* (1.12-3.65)	1.98* (1.08-3.61)	2.58*** (1.46-4.56)	2.31** (1.29-4.14)	2.01* (1.09-3.70)
Change in perception of access						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.17 (0.66-2.05)	1.11 (.062-1.99)	0.99 (0.54-1.80)	0.78 (0.45-4.56)	1.01 (0.58-1.77)	1.00 (0.56-1.78)
Change in perception of traffic						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	0.40** (0.22-0.72)	0.29*** (0.15-0.54)	0.39** (0.21-0.73)	1.58 (0.91-2.72)	1.76* (1.01-3.05)	1.41 (0.79-2.48)
Location						
Non-coastal	1.00	1.00	1.00	1.00	1.00	1.00
Coastal	0.68 (0.37-1.22)	0.63 (0.34-1.15)	0.49* (0.27-0.91)	1.35 (0.75-2.43)	0.90 (0.50-1.63)	1.06 (0.57-1.96)

*p<.05 **p<.01 ***p<.001

Hypothesis 2 was not supported for women, there was no association of coastal versus non-coastal location with increased walking for women.

Generally, *Hypothesis 3* was not supported. The strength of the association was not found to lessen, for both men and women, as more stringent outcome (greater increase in walking) criteria were applied. Relatively similar strengths in associations were found across all three outcome categories.

3.5.3 Summary of the findings of the prospective study

To examine associations of changes in environmental perceptions with changes in the specific behaviour of walking, three outcomes were used (any increase, 30 minutes or more, 60 minutes or more) to test the associations across increasingly exacting criteria. This is because small increases in self-reported walking, while significant, could nevertheless be within the range of measurement error for self-reported physical activity (Sallis & Saelens, 2000). Generally, results showed similar strengths of association for any increases in walking and for increases of 60 minutes or more.

This prospective study found that self-reported perceptions of neighbourhood environmental attributes did change over time. Those who initially had the least positive perceptions demonstrated the greatest increase, and those with initially more-positive perceptions remained stable or showed some decrease in scores. This might be explained in terms of regression to the mean. However, this finding is consistent with what would be expected from the outcomes of earlier studies

(Humpel et al., 2002), which reported that those who were already active (and thus less likely to become more so) had the most positive perceptions of environmental attributes.

The differences in the findings for the men and for the women further emphasize the need to carry out gender-specific analyses in physical activity studies (Sallis, Hovell, & Hofstetter, 1992). An increase in positive perceptions of the environment was found to be more strongly associated with increased walking for men than for women.

With improved perceptions of ‘aesthetics’, men were twice as likely to increase their walking more than 30 minutes, but for women, this association was non-significant. An increase in perceived ‘convenience’ proved to be a strong predictor of increased walking for both men and women.

The data for both men and women showed no significant associations of changes in perceived ‘access’ to services with an increase in walking across any of the outcome categories. Changes to how close or far participants perceived the distance to shopping venues and other facilities were not related to any increases in walking.

Changes in the perception of ‘traffic’ as a problem and its association with increased walking are of interest. The direction of the association was positive for women, but was negative for men. Men who perceived traffic to be less of a problem were less likely to increase their walking in or around their neighbourhood. This is counter-intuitive, but is consistent with the findings of the cross-sectional study explained

previously (see 3.4), where high scores on ‘traffic’ were associated with a decreased likelihood of neighbourhood walking for men.

3.6 Limitations of the Studies Reported in Part 3

The data used in the studies of Part 3 were collected from participants who were part of an intervention trial, and although the intervention was not designed to influence their perceptions of their neighbourhood environment it cannot be ruled out as a possibility. Self-instructional physical activity interventions, similar to that used in the trial that provided the context for the studies, often identify specific settings and opportunities for activity in their program materials (Bock, Marcus, Pinto, & Forsyth, 2001). An attempt to control for the effect of the interventions was employed by entering the variable ‘dose’ of intervention into the logistic regression models.

The majority of the participants in the sample of the studies resided in the Illawarra district. The geographical nature of this district is that of a long narrow strip between the mountains and the coastline, resulting in a limited variation in the environment and possibly a generally more ‘aesthetic’ appeal overall (Blakely & Woodward, 2000). This may limit the generalisability of the results to other geographical settings.

The cross-sectional design of the baseline study limits the conclusions that can be drawn from the results. The prospective study, while more powerful than a cross-sectional design, still does not give evidence of causal relationships.

All data were collected via self-report telephone interview, and as such these data may be subject to biasing influences, compared to data collected from objective measures (Bauman et al., 2002; Sallis et al., 1990; Troped et al., 2001). Numerous limitations of self-report have been reported (Ainsworth, Montoye, & Leon, 1994; Durante & Ainsworth, 1996; Sallis & Saelens, 2000). Self-report measures typically have relatively high levels of measurement error. Social desirability can lead to over reporting of physical activity. Recalling and reporting physical activity is a complex task and can result in over or under reporting of the duration and/or frequency of the activity.

The generalisability of results from the studies of Part 3 is limited due to the nature of the study sample. The sample comprised university staff, of whom 71% had tertiary education, although it should be noted that 52.5% of the study sample were general, rather than academic staff. Higher education levels have been shown to be related to higher levels of physical activity participation among Australian adults (Owen & Bauman, 1992).

3.7 Implications of the Studies

The changes in perceptions of environmental attributes reported in the prospective study occurred over a relatively short time period (ten weeks), and it is not known whether the changes would be maintained or fluctuate over a longer period. If the changes in perceptions of 'aesthetics' and 'convenience' were maintained over the longer term, and were associated with sustained increases in walking, then these factors may be more likely to be acting as causal influences. It is, however, possible

that those who became more active began to more accurately perceive their environment, thus leading to the relationships that have been reported.

These findings do not demonstrate causal relationships, but they do add to the body of evidence (Humpel et al., 2002) that there are relationships between people's perceptions of their environments and their physical activity behaviours. To conclude that such relationships are causal will require a larger quantity of evidence from further prospective studies using different designs, demographic groups, and differing environmental settings.

PART 4

CROSS-SECTIONAL AND PROSPECTIVE ASSOCIATIONS OF ENVIRONMENTAL ATTRIBUTES WITH WALKING: COMMUNITY SAMPLE

4.1 Introduction

The study reported in Part 3 (sections 3.4 and 3.5) was the first to prospectively examine perceptions of environmental attributes, and demonstrate significant associations with walking behaviour. A next step is to again test these environment-behaviour relationships to see if they can be replicated in a different sample. In both cross-sectional and prospective studies, Humpel et al. (in press) found significant associations of coastal location with neighbourhood walking for men. Perceptions of the ‘aesthetic’ nature of the neighbourhood environment, ‘convenience’ of facilities for walking, and ‘access’ to services were all found to be significantly associated with neighbourhood walking in both the cross-sectional and prospective studies of Part 3 (Humpel, Marshall, Leslie, Bauman, & Owen, in press; Humpel, Owen et al., in press). As the previous study used a workplace sample, a broader community sample was chosen for the studies reported in Part 4.

The conclusions from the workplace study may have been limited by the small number of items measuring the perceived neighbourhood environment on which it was based. In order to fully evaluate the importance and the influence of perceptions about the neighbourhood environment on walking behaviour, a more extensive range of measures is needed. The next study expands on the measurement base established

in Part 3 (see Humpel et al., in press; Appendices A-2 and A-3) with an extended range of perceived neighbourhood environment variables that substantially increased the components of the environment examined.

Additional items about safety and footpaths were sourced from the Neighborhood Quality of Life Study (Saelens et al., in press), a survey developed to assess neighbourhood environment characteristics. The effect of weather and season has received some attention in the transportation literature (Saelens et al., 2003), but little in the health and physical activity literature (Matthews et al., 2001; Uitenbroek, 1993). Further items were included to assess the influence of the weather on participation in walking as previous studies had mainly examined this factor in composite measures examining ‘barriers’ to physical activity (Humpel et al., 2002; Saelens et al., 2003). Due to the differing findings for men and women with regards to ‘traffic’ as a problem in the studies of Part 3, an extra item asking about ‘crossing a busy street’ was included.

Part 4 also expands on the significant findings from Part 3 for neighbourhood walking by further testing the proposal that ecological frameworks need behaviour-specific models. Participation in walking can occur for several different purposes (Saelens et al., 2003), and can occur in different settings (Humpel, Owen et al., in press). Examination of environmental attribute associations with the different purposes for walking will further substantiate the usefulness of a behaviour-specific model. Measures of a greater range of differentiated walking types, including walking for exercise, for pleasure and to get to and from places are included in the studies of Part 4. Attributes of the environment that influence general walking in the

neighbourhood may be different to those that influence walking for exercise or recreation in any location, or walking to get to and from places.

The aims of the two studies reported here in Part 4 were: Firstly, to examine the predictive power of an extended set of environmental attribute items that may influence walking in the general community population. Secondly, to further test the ‘specificity of outcome’ hypothesis previously proposed by examining a greater range of differentiated walking outcomes. The four walking outcomes measured were:

- Neighbourhood walking
- Exercise walking
- Walking for pleasure
- Walking to get to and from places

As was reported in the studies of Part 3, these relationships are examined both cross-sectionally (sections 4.2 to 4.4) and prospectively (sections 4.5 and 4.6) in Part 4.

4.2 Cross-Sectional Study of Associations of Environmental Attributes with Walking Behaviour: Hypotheses and Methods

Based on the findings from the studies reported in Part 3 (Humpel, Marshall et al., in press; Humpel, Owen et al., in press), the hypotheses for the cross-sectional study of Part 4 were:

1. Participants living in a coastal place of residence will be more active on all walking indices than will those living in a non-coastal place of residence.

2. The environment-walking relationships found for neighbourhood walking in the cross-sectional study of Part 3 will be replicated in the cross-sectional study of Part 4
3. An extended range of perceived environmental factors will have different patterns of association relationships with the four walking outcomes.

4.2.1 Study sample and procedures

Participants were clients of a health insurance organization that provides telephone-delivered prevention and disease-management services. Two criteria were used for selecting the study sample: clients aged over 40 years of age, as walking levels have been shown to be less prone to decline in the middle-age and older age-groups compared to other types of activities (Morris & Hardman, 1997; Siegel et al., 1995); and clients residing in the Illawarra region (a mainly coastal community some 80 kilometres south of the state capital, Sydney). A total of 982 potential respondents met these two criteria and were mailed the survey. The response rate was 43% ($n = 429$). Of these, 30 surveys were incomplete, leaving a final sample of 399.

4.2.2 Measures

The mail survey comprised of demographics (age, education, gender), items pertaining to walking, perceptions of the neighbourhood environment, and location of participants' residence by postal code. A complete copy of the baseline survey is included in Appendix B-4.

Walking. Consistent with the rationale for behaviour-specific and context-specific measurement explained in section 1.3.3 (Owen et al., 2000; Sallis & Owen, 1997, 2002) and the need to examine walking for different purposes (Saelens et al., 2003), four items were used to assess walking behaviours. These items consisted of the same neighbourhood walking measure used previously plus three new measures of walking; walking for exercise; walking for pleasure and walking to get from place to place. The walking items asked about ‘usual’ behaviour.

For neighbourhood walking, participants were asked: “How many times a week do you go for a walk for any reason (e.g., for exercise, doing errands, walking for transport) in and around your neighbourhood?” “How much time would you usually spend when you do go for a walk in and around your neighbourhood?”

For walking for exercise, participants were asked: “What is the average number of times per week you spend walking in your neighbourhood or elsewhere, for exercise for at least 10 minutes at a time?” “What is the average number of minutes you spend walking each time?” This was repeated for walking for pleasure (social) and for walking to get to and from places.

The frequency of walking was multiplied by the number of usual minutes, to give an index of reported minutes of walking each week, for each type. Although the focus of this study was on walking behaviour, an additional item asked about other types of physical activity (results are not reported here).

Reliability of the ‘neighbourhood walking’ item was examined and has been reported in Part 2.3.2. The item was found to have excellent test-retest agreement (ICC = 0.92).

For all analyses, the four walking outcome measures were dichotomised at the median score. The median score for neighbourhood walking was 150 minutes per week; exercise walking was 120 minutes per week; for walking for pleasure and to get to and from places the median score was zero minutes resulting in any, or none walking categories for these two outcomes.

Perceived environmental attributes. Neighbourhood environment attribute items were based on findings from the review of studies that assessed relationships between environment attributes and physical activity behaviours (Humpel et al., 2002; Part 1.4), the eight items used in the studies of the workplace sample in Part 3, and neighbourhood items from the Neighbourhood Environment Walkability Scale (Saelens et al., in press). A total of 24 items assessed different aspects of the environment including, how close or convenient places for walking were in their neighbourhood (for example, public transport, a park, shops), whether they felt their neighbourhood was pleasant for walking (for example, enjoyable scenery, attractive) and also items about safety and the influence of the weather on walking.

As this was a mailed survey, to promote simplicity for answering, each perceived environment item was based on semantic differential principles (Brinton, 1976; Brinton, 1976), where the anchors were the most negative, and the most positive result for that situation. Participants were asked to tick the most appropriate value on

a 10-point scale. See Appendix B-6 for a full list of the study environmental attribute items. For the test-retest reliability for eight of the 24 environmental attribute items, see Part 2.3.1. The intra-class correlations (by absolute agreement) for these items ranged from 0.73 to 0.91.

Location by postal code. Participants were asked for their postal code as in the studies of Part 3 (see Part 3.2.2). This variable was coded into non-coastal (27% of participants) and coastal (73% of participants) location.

4.2.3 Methods of analysis

All analyses were conducted using SPSS v11.0. First, principal component analysis using varimax rotation was used to identify groups of related environmental attributes. Second, bivariate and multivariate analyses were conducted.

The main analysis used a series of logistic regression models to examine the association between ‘location’ and the four identified perceived environmental factors, with the four outcome variables; neighbourhood walking, walking for exercise, walking for pleasure and to get to and from places. All models were adjusted for age and education level and stratified by gender. A significance level of 0.05 was set for all statistical analyses.

4.3 A Test of the Replicability of the Environmental Attribute Categories from the Cross-Sectional Study of Part 3 with Neighbourhood Walking, Exercise Walking, Pleasure Walking and Walking to get to and from Places

4.3.1 Methods of analysis

Before examining associations of the broader set of perceived environmental attributes with the four walking outcomes, a replication study was attempted. The first analysis conducted in Part 4 was a test of the replicability of the analysis conducted in the cross-sectional study of Part 3 (sections 3.2 and 3.3) using only the same eight environmental attribute items. In Part 3.2.3, the eight items measuring perceived environmental attributes were ‘logically’ grouped into four categories; aesthetics, convenience, access to services, and traffic as a problem. As in Part 3, the summed scores for the four groupings were again transformed into categorical variables with three levels: low, moderate and high with cut-off points that most closely approximated the tertiles of the distribution. These environmental attribute categories from Part 3 were examined for associations with the neighbourhood walking item from the studies of Part 3, and the three new walking outcomes of the studies of Part 4.

A series of logistic regression models for men and women were conducted. All models included age, education level, the four perceived environment categories and location of residence.

4.3.2 Results for the test of replicability of Part 3 environmental categories

Men with the most positive perceptions of ‘aesthetics’ were nearly six times as likely to be high neighbourhood walkers compared to those with the least positive perceptions (Table 4.1). ‘Convenience’, ‘access’ to services, ‘traffic’ as a problem

and location, did not evidence a relationship with neighbourhood walking for men. The only significant finding for women for neighbourhood walking was evidenced for 'location'. Women living in coastal location were more than three times as likely to be high neighbourhood walkers. This result must be viewed with caution though, as the overall model chi-square for women was not statistically significant ($\chi^2 = 18.16, p = 0.1$).

For walking for exercise, men with most positive perceptions of 'aesthetics' were over six times as likely to do more walking for exercise compared to those with the least positive perceptions (Table 4.1). Those men with moderate perceptions of 'access' to services were 2.84 times more likely to do more walking for exercise. No significant relationships were evidenced for the environmental categories with walking for exercise for women. Results for environmental categories with walking for pleasure and walking to get to places (data not shown) found no significant findings for men or women.

This study did not replicate the findings in the cross-sectional study of Part 3 (sections 3.2 and 3.3). Fewer significant findings were reported in this study compared to the study of Part 3 for the relationship between perceptions of the neighbourhood environment and neighbourhood walking. The strongest relationship was found for 'aesthetics' with neighbourhood walking in men. There were no significant findings for walking for pleasure and walking to get to and from places.

Table 4.1: Logistic Models Stratified by Gender: Odds Ratios and 95%CI for Location and each Category of Environmental Attributes and the Likelihood of Being in the Higher Level of Participation Category for Neighbourhood and Exercise and Walking

		Men		Women	
		Neighbourhood walking	Walking for exercise	Neighbourhood walking	Walking for exercise
Location					
Non-coast	1.00		1.00	1.00	1.00
Coast	1.29 (0.55-3.00)		1.64 (0.70-3.84)	3.26 (1.55-6.87)**	1.37 (0.65-2.86)
Aesthetics					
Low	1.00		1.00	1.00	1.00
Moderate	3.48 (1.37-8.86)**		5.56 (2.04-15.12)**	1.58 (0.67-3.71)	2.19 (0.94-5.10)
High	5.82 (1.95-17.35)**		6.65 (2.15-20.57)**	1.10 (0.47-2.53)	1.69 (0.74-3.85)
Convenience					
Low	1.00		1.00	1.00	1.00
Moderate	0.82 (0.31-2.19)		0.85 (0.31-2.33)	1.72 (0.72-4.10)	1.09 (0.46-2.58)
High	0.86 (0.31-2.39)		0.78 (0.27-2.21)	1.21 (0.46-3.15)	1.18 (0.45-3.06)
Access					
Low	1.00		1.00	1.00	1.00
Moderate	1.12 (0.43-2.88)		2.84 (1.05-7.63)*	0.97 (0.41-2.31)	0.90 (0.39-2.09)
High	1.23 (0.44-3.44)		1.07 (0.38-3.05)	1.22 (0.50-2.98)	1.07 (0.45-2.56)
Traffic					
Low	1.00		1.00	1.00	1.00
Moderate	0.74 (0.27-2.04)		0.40 (0.14-1.17)	0.66 (0.27-1.62)	0.51 (0.20-1.25)
High	1.06 (0.36-3.12)		0.36 (0.11-1.14)	1.26 (0.51-3.10)	0.84 (0.65-2.06)

* p<.05 ** p<.01 *** p<.001

4.4 Cross-Sectional Associations of the Broader Set of Perceived Environmental Attributes with Walking Behaviour: Outcomes

4.4.1 Factor analysis of perceived environmental attributes

The mean scores and standard deviations for each individual environmental attribute item for the total group, and men and women are reported in Appendix D-1. To explore the underlying structure in the items used to measure perceptions of the neighbourhood environment, an exploratory principal component analysis (PCA) was conducted. A correlational matrix showed a large number of coefficients with values exceeding .3, indicating evidence of reasonable relationships between the variables (Howell, 1997; Tabachnik & Fidell, 2002). The item ‘overall convenience’ was not included in the PCA as it was viewed as a global measure of environmental perceptions and was examined separately. The item ‘someone to walk with’ was also excluded as this item was viewed as a social support measure and was also examined separately. After the initial rotation, two items; ‘lots of trees’ and ‘no litter’ were excluded from further analysis as they cross-loaded across several of the factors or did not fit with the interpretation of the factors. The final solution identified four factors with eigenvalues greater than one (Howell, 1997; Tabachnik & Fidell, 2002), accounting for almost 56% of the variance (Table 4.2).

The final factors were interpreted as ‘accessibility’ of facilities for walking (eight items), ‘aesthetics’, ‘safety’, and ‘weather’ as a influence on walking, each comprised of four items. Loadings ranged from 0.49 to 0.89 across the four factors. Cronbach’s

alpha coefficient of internal consistency was calculated for each sub-scale. All scores were above the 0.70 recommended level (Murphy & Davidshofer, 1998; Table 4.2).

Table 4.2: Factor Loadings from Principal Component Analysis using Varimax Rotation

	Accessibility	Aesthetics	Safety	Weather
Not hilly	.707		.210	
Cycleway	.667	.214		
Park	.602	.245		
Lake/beach	.541	.238		
Transport	.590			
Shops	.675			
Different routes	.489	.375		
Footpaths	.635		.410	
Pleasant	.296	.687	.328	
Scenery		.895		
Attractive		.889		
Friendly		.690	2.07	
No busy roads		.337	.615	
Less traffic	.258	.204	.697	
Feel safe		.359	.696	
Less dogs			.592	
Windy				.847
Rain				.702
Cold			.265	.819
Hot		.300		.587
Cumulative %	16.57	32.72	44.46	55.89
Coefficient alpha	.81	.88	.73	.77

Items in each factor were then summed to provide a total score for each category of environmental attribute. These summed scores were then divided by the number of items in each category. This facilitated comparison across the categories, with all having a final score out of ten (see Table 4.4). The scores of ‘aesthetics’, ‘accessibility’, ‘safety’ and ‘weather’ were transformed into categorical variables with three levels: low (a less positive perception of the environment); moderate; or high (a highly positive perception of the environment). A high score for ‘weather’ meant that the weather did not inhibit their walking. The cut-off points used for these levels were those that most closely approximated the tertiles of the distributions.

4.4.2. Characteristics of participants

Characteristics of participants can be found in Table 4.3. The sample consisted of a greater proportion of women than men with a mean age of 60 (SD = 11) years. A larger proportion of men were over 60 years, whereas the larger proportion of women was under 60 years. Overall, participants were an active group, with the mean minutes of neighbourhood walking for both men and women being above the recommended ‘sufficient’ activity for health benefits of 150 minutes per week (USDHHS, 1996).

Table 4.3: Characteristics of the Sample and Distribution by Location.

	Men % (n)	Women % (n)
Gender	42.6 (170)	57.4 (229)
Age		
40-59 years	44.6 (75)	56.6 (128)
60 + years	55.4 (93)	43.4 (98)
Education		
≤ 12years	27.3 (45)	56.5 (122)
Trade/Technical	46.7 (77)	23.6 (51)
University	26.1 (43)	19.9 (43)
Location		
Non-coastal	28.7 (48)	26.0 (59)
Coastal	71.3 (119)	74.0 (168)

Table 4.4: Means and Standard Deviations for Minutes of Walking, by Type and by Scores on Perceived Environmental Attribute Factors

	Men	Women
Walking		
Neighbourhood	187 (181)	171 (128)
Exercise	124 (124)	137 (113)
Pleasure	32 (58)	31 (62)
To get to places	32 (56)	29 (48)
Environment		
Aesthetics	8.19 (1.6)	8.33 (1.7)
Accessibility	6.37 (1.9)	6.45 (2.0)
Safety	7.88 (1.7)	7.72 (1.8)
Weather	6.28 (2.0)	6.06 (2.2)

Men demonstrated higher mean minutes of walking in their neighbourhoods for pleasure and to get to and from places, whereas women reported higher mean minutes of walking for exercise (see Table 4.4). None of these gender differences in walking were statistically significant. Overall, high scores were found for the four perceived environment factors with men slightly higher for 'safety' and 'weather', and women slightly higher for 'aesthetics' and 'accessibility', although again none of the differences were significant.

4.4.3 Bivariate relationships between environmental attributes, participant characteristics and walking behaviours

A significant difference between the age groups was found for walking for pleasure. The proportion of those aged over 60 years (28.8%) who walked for pleasure was significantly less than for those under 60 years (46.2%); $\chi^2 = 12.24$, $p < .000$ (Table 4.5). The same but smaller trend was apparent for exercise walking; however, for neighbourhood walking, an opposite (but non-significant) trend was apparent (Table 4.5). There was a trend for women to participate more in neighbourhood and exercise walking, while more men tended to participate in walking for pleasure and in walking to get to and from places.

Table 4.5: Proportions of Participants in the High Level of each Type of Walking for Gender, Age and Education level and by Perceived Environmental Factors and Location.

	Neigh/hood	Exercise	Pleasure	To get places
Gender				
Total sample	52.1	54.2	38.0	48.4
Men	50.9	51.5	40.5	49.7
Women	52.9	56.3	35.9	47.5
Age				
40-59	49.2	55.8	46.2	48.5
60+	55.3	53.0	28.8***	48.1
Education				
≤ 12 years	52.7	59.3	38.8	50.9
Trade/ Technical	54.0	51.6	34.7	40.7
University	47.7	47.7	43.0	54.1
Aesthetics				
Low	39.0	42.9	34.3	55.2
Moderate	52.5	58.5	37.9	44.7
High	66.7***	60.9*	40.8	50.0
Accessibility				
Low	46.5	42.9	29.5	45.0
Moderate	53.8	54.9	44.1	50.5
High	60.3	62.7**	45.2*	52.8
Safety				
Low	46.5	46.9	37.2	53.2
Moderate	49.3	49.6	43.3	52.2
High	60.3+	65.3**	32.8	40.2+
Weather				
Strong influence	33.9	34.5	36.3	50.9
Moderate	55.9	50.9	41.8	49.1
Not an influence	67.4***	74.8***	33.6	50.0
Location				
Non-coastal	38.5	46.6	31.4	40.6
Coastal	57.5**	57.0+	40.3	51.2+

+ p<.07 * p<.05 ** p<.01 *** p<.001

The proportions of participants in the high neighbourhood walking and high exercise walking categories increased with increasingly more positive perceptions of the environment (Table 4.5). Higher proportions of neighbourhood walkers were found among those with high perceptions for ‘aesthetics’ ($\chi^2=17.08$, $p<.000$). A total of 66.7% of those with the most positive perceptions were in the high neighbourhood walking category compared to 39% for those with the least positive perceptions of neighbourhood ‘aesthetics’. A higher proportion (67.4%) of neighbourhood walking was found among those reporting ‘weather’ as not to be an influence ($\chi^2 = 27.98$, $p<.001$).

Higher proportions of those walking for exercise were found among those with the most positive perceptions for all four environmental-perception factors. For walking for pleasure, those with moderate and the most positive perceptions for ‘accessibility’ had a much larger proportion of walkers ($\chi^2 = 7.28$, $p<.026$) compared to those with the least positive perceptions. No significant differences in proportions were found for walking to get from place to place.

Place of residence. No significant gender or education differences were found for specific coastal versus non-coastal location identified by postal code. The proportions of participants over 60 years living in a coastal location (78.0%) was significantly more than for those less than 60 years (68.7%; $\chi^2 = 4.37$, $p<.037$). A larger proportion of coastal than non-coastal residents were in the high level group for each type of walking (see Table 4.5). The proportions of participants (57.5% of coastal) differed significantly on neighbourhood walking ($\chi^2 = 11.01$, $p<.001$), and the difference approached significance for exercise walking and walking to get to and from places (p

<.07). The findings for neighbourhood walking lend support to *Hypothesis 1*, that participants living in a coastal residence will be more active than those living in a non-coastal location. In this cross-sectional study, a larger proportion of coastal participants than non-coastal participants reported a higher level of participation in all four walking outcomes (only significant for neighbourhood walking).

Significant differences in mean minutes of neighbourhood walking were found for 'location' ($F(1,382) = 5.10, p < .025$). Participants living in a coastal location ($M = 189$ mins) walked significantly more in their neighbourhood than did participants in a non-coastal location ($M = 149$ mins). Location differences for walking for exercise were also found to be significantly different ($F(1,385) = 5.10, p < .024$). Coastal residents reported more minutes of walking for exercise ($M = 139$ mins) compared to non-coastal residents ($M = 109$ mins). Differences in 'location' for mean scores for the environmental attribute factors of 'aesthetics', 'accessibility', 'safety' and 'weather' were non-significant

4.4.4 Multivariate analyses: predictors of walking behaviours

Neighbourhood walking. Neighbourhood 'aesthetics' was found to be strongly associated with neighbourhood walking for men (Table 4.6). Men with the most positive perceptions about the aesthetic nature of the environment were more than seven times more likely to be high neighbourhood walkers. 'Weather' was related to neighbourhood walking. Those men who reported that the weather was not influencing their walking habits were more than four times as likely to be high neighbourhood walkers.

Accessibility of facilities for walking had a negative relationship with neighbourhood walking. Those men who perceived facilities close and available were less likely to be in the high neighbourhood walking category.

For women, there was also a significant relationship of ‘weather’ with neighbourhood walking (Table 4.7). Women who reported that the weather was not influencing their walking habits were more than three times as likely to be in the high neighbourhood walking category. Women living in a coastal ‘location’ were three times more likely to be high neighbourhood walkers. For men, there was a similar trend for ‘location’ although the odds ratio was non-significant. No evidence of a relationship for ‘safety’ with neighbourhood walking was found for men or women.

The neighbourhood walking results give support to *Hypothesis 2*, that the environment-walking relationship found for neighbourhood walking in the cross-sectional study of Part 3 would be replicated in this cross-sectional study. For men, significant relationships were evidenced for three of the four perceived environmental attribute factors. Although only one significant perceived environment association with neighbourhood walking was found for women, this finding of fewer associations than for men is also a replication of the findings from Part 3.

Table 4.6: Logistic Regression Models for Men: Odds Ratios and 95%CI for Location and each Environmental Variable Factor and Likelihood of Being in the High Category of Participation for each Walking Type.

	Men			
	Neighbourhood walking	Exercise walking	Pleasure (social) Walking	Walking to get to and from places
Location				
Non-coast	1.00	1.00	1.00	1.00
Coast	1.69 (0.69-4.18)	1.72 (0.70-4.19)	1.59 (0.64-3.95)	0.94 (0.40-2.19)
Aesthetics				
Low	1.00	1.00	1.00	1.00
Moderate	1.92 (0.63-5.86)	2.06 (0.68-6.26)	1.47 (0.78-4.57)	0.94 (0.33-2.64)
High	7.43 (1.92-28.82)**	3.86 (1.03-14.46)*	1.45 (0.38-5.49)	0.64 (0.19-2.17)
Accessibility				
Low	1.00	1.00	1.00	1.00
Moderate	1.14 (0.39-3.29)	2.57 (0.89-7.46)	0.91 (0.33-2.51)	1.10 (0.43-2.85)
High	0.30 (0.09-0.91) *	0.70 (0.25-2.01)	2.02 (0.68-5.98)	1.40 (0.50-3.87)
Safety				
Low	1.00	1.00	1.00	1.00
Moderate	0.98 (0.31-3.01)	1.23 (0.40-3.82)	0.54 (0.18-1.65)	0.58 (0.20-1.68)
High	0.91 (0.27-3.06)	1.04 (0.31-3.58)	0.22 (0.60-0.78)*	0.54 (0.17-1.67)
Weather				
Strong influence	1.00	1.00	1.00	1.00
Moderate	4.09 (1.44-11.66)**	4.08 (1.42-11.74)**	1.37 (0.51-3.68)	0.92 (0.59-4.29)
Not an influence	4.71 (1.60-13.91)**	5.48 (1.83-16.38)**	0.58 (0.20-1.69)	1.60 (0.40-2.19)
Age				
40-59 years	1.00	1.00	1.00	1.00
60+ years	1.59 (0.66-3.87)	0.95 (0.40-2.25)	0.33 (0.14-0.81)*	1.90 (0.84-4.31)

*p<.05 **p<.01

Table 4.7: Logistic Regression Models for Women: Odds Ratios and 95%CI for Location and each Environmental Variable Factor and the Likelihood of Being in the High Category of Participation for each Walking Type.

Women				
	Neighbourhood walking	Exercise walking	Pleasure (social) Walking	Walking to get to and from places
Location				
Non-coast	1.00	1.00	1.00	1.00
Coast	3.32 (1.51-7.29)**	1.40 (0.62-3.18)	1.65 (0.72-3.82)	1.83 (0.87-3.85)
Aesthetics				
Low	1.00	1.00	1.00	1.00
Moderate	1.74 (0.65-4.62)	1.78 (0.63-5.02)	0.80 (0.28-2.24)	0.59 (0.23-1.48)
High	1.12 (0.41-3.12)	0.75 (0.25-2.26)	0.84 (0.29-2.42)	0.84 (0.31-2.25)
Accessibility				
Low	1.00	1.00	1.00	1.00
Moderate	1.12 (0.47-2.66)	1.31 (0.51-3.42)	3.51 (1.35-9.15)*	1.36 (0.58-3.19)
High	1.76 (0.70-4.47)	1.42 (0.52-3.88)	2.61 (0.97-6.97)	1.61 (0.67-3.86)
Safety				
Low	1.00	1.00	1.00	1.00
Moderate	0.66 (0.26-1.63)	0.69 (0.26-1.84)	1.68 (0.65-4.33)	0.74 (0.31-1.76)
High	1.09 (0.40-2.96)	2.64 (0.90-7.82)	1.13 (0.40-3.19)	0.56 (0.22-1.45)
Weather				
Strong influence	1.00	1.00	1.00	1.00
Moderate	1.93 (0.86-4.36)	1.03 (0.45-2.36)	0.62 (0.65-4.33)	0.77 (0.35-1.72)
Not an influence	3.84 (1.68-8.77)**	7.68 (3.03-19.46)***	0.93 (0.41-2.07)	0.73 (0.34-1.57)
Age				
40-59 years	1.00	1.00	1.00	1.00
, 60+ years	1.06 (0.52-2.16)	0.45 (0.21-1.00)	0.41 (0.19-0.87)*	1.00 (0.51-1.96)

*p<.05 **p<.01 ***p<.001

Walking for exercise. For walking for exercise among men, ‘aesthetics’ and ‘weather’ were significant correlates (Table 4.6). Those men with a high score on ‘aesthetics’ were nearly four times as likely, and those with the highest scores for ‘weather’ (weather not an influence) were nearly six times more likely to walk for exercise.

For women, those with the highest score for ‘weather’ were over seven times more likely to walk for exercise (Table 4.7). Whether men or women lived in a coastal ‘location’ was not associated with more walking for exercise.

Walking for pleasure and to get to and from places. ‘Safety’ was found to be negatively associated with walking for pleasure for men (Table 4.6). Those men who perceived their environment as safest for walking were less likely to walk for pleasure. Age was also found to be associated with walking for men. Men aged 60 years and over were less likely to walk for pleasure.

Women (Table 4.7) with moderately positive perceptions about ‘accessibility’ were more than three times more likely to walk for pleasure ($p < .01$), and women 60 years and over were less likely to walk for pleasure ($p < .02$). These findings on women’s walking for pleasure need to be viewed with caution as the logistic regression model reported borderline significance ($\chi^2 = 20.87$, $p < .052$). The logistic regression model found neither perceived environmental attributes nor ‘location’ to be associated with walking to get to and from places.

The results reported above give reasonable support to *Hypothesis 3*, that the extended range of perceived environmental variables would demonstrate different patterns of associations with the four walking outcomes. Significant relationships were evidenced for all four factor groupings of the extended range of environmental perception items, but the significant relationships were not with all four walking outcomes. Different factors were found related to different types of walking.

4.4.5 Summary of the findings of the cross-sectional study

The principal component analysis findings gave reasonable support to the previous hypothetical groupings of environmental attribute variables (Humpel, Owen et al., in press). Items that were previously grouped as ‘aesthetics’, were also grouped in the present study by statistical factor ‘loadings’ as ‘aesthetics’. Items that were previously grouped as ‘convenience’ and ‘access’ to services, were statistically grouped here as what was interpreted to be an ‘accessibility’ factor. Additional perceived environment items loaded as a ‘safety’ factor (personal and traffic safety together), and the four items pertaining to the influence of the ‘weather’ loaded highly on the same factor.

Safety did not prove to be an important influence on neighbourhood or exercise walking for this sample of adults. Men who perceived their environment as safest were less likely to walk for pleasure. Perhaps by not walking for pleasure, these men have not been in the position to think about their neighbourhood in terms of safety. Although there was a trend for women in relation to perceptions of ‘accessibility’ with neighbourhood and exercise walking, significant associations only emerged with walking for pleasure. A significant association with age for walking for pleasure was found for both men and women. But, contrary to what might be expected, those over 60 years of age were less likely to walk for pleasure. It may be that around retirement age and older, walking may be perceived as being more for the purposes of exercise and for health reasons.

An unexpected finding was that, of the four perceived environment factors, ‘weather’ demonstrated the strongest association with walking for both men and women. Those participants with the most positive perceptions, that is, weather was not an important

influence on their walking, were most likely to participate in higher levels of neighbourhood walking and walking for exercise. Although the weather is often reported as a barrier to physical activity (Matthews et al., 2001; Uitenbroek, 1993), few, if any, studies have examined this variable using multivariate models. This issue needs to be further explored in future studies.

The strong relationship of coastal location with neighbourhood walking for women is puzzling, particularly because of the weak associations found for the perceived environmental attributes. The 'location' attribute is an objective measure and the environmental attributes are the womens' perceptions, this could perhaps be an important difference. In the cross-sectional study of Part 3 (Humpel, Owen et al., in press) the coastal association was found for men. The gender difference in the 'location' findings of the two studies may be related to the age differences of the two samples. In the previous study the mean age was 43 years with very few participants over 60 years, whereas for this study, the mean age was 60 years. A larger proportion of people over 60 years of age were found to live in a coastal location as compared to those less than 60 years. Environmental influences on walking may change for men and women with increasing age and retirement from work.

No relationships were found between any environmental perceptions and walking to get to and from places. It is possible that, if a person needs or chooses to walk to work, or to a bus stop for transport for practical reasons, then she/he does it regardless of perceptions of the neighbourhood environment.

An aim of this study was to test propositions consistent with behaviour-specific models of environmental influence on physical activity behaviour. Different environmental attribute categories were found related to different types of walking. 'Weather', 'aesthetics', 'accessibility' and 'location' were associated with neighbourhood walking. 'Weather' and 'aesthetics' were found to be associated with walking for exercise. 'Safety' and 'accessibility' were associated with walking for pleasure. None of the neighbourhood environmental attributes were found to be associated with walking to get from place to place. Walking to get to and from places was found not related to perceptions about the environment compared to walking by choice, that is, for exercise or for pleasure. Although 48.4% of the sample reported doing some walking to get to and from places, this was only small amounts (mean= 32 minutes per week), and could have made any association harder to detect.

These findings support the need to focus the broad framework of ecological models into models for specific behaviours. By exploring behaviour as specifically as possible, and not using 'total' or generic measures of activity, a clearer picture emerges of the relevant environment-behaviour relationship.

Overall, the cross-sectional data from the baseline study found significant associations for the extended range of environmental perceptions items and the objective measure 'location' with different walking behaviours.

In the following sections (4.5 and 4.6) these relationships are examined prospectively.

4.5 Prospective Study of Relationships Between Changes in Perceptions of Environmental Attributes and Changes in Walking Behaviour: Hypotheses and Methods

Sections 4.2.1 to 4.2.3 describe the attributes of participants in the cross-sectional study, the study measures and procedures. Here additional information is provided that is relevant to the prospective study described. As explained in Part 3 (section 3.2) studies using a prospective design are needed to advance knowledge on the relationships between environmental perceptions and walking behaviour, as previous studies have all been cross-sectional in design.

The hypotheses for this study are based on the findings of the prospective study from Part 3, and the cross-sectional results reported in section 4.4. The prospective study of Part 3 found that positive changes in ‘aesthetic’ nature of the environment, changes in ‘convenience’ of facilities and changes in perceptions of ‘traffic’ as a problem to be significantly related to changes in neighbourhood walking (section 3.5).

It was expected that in this prospective study, these associations of changes in perceived environmental attributes with changes in the behaviour of neighbourhood walking may again emerge. It was hypothesised that changes in perceptions of environmental attributes of the local neighbourhood would also be related to exercise walking and walking for pleasure as they also usually occur within the neighbourhood setting (Pikora et al., 2002). The strength of the associations was hypothesised to be less for walking to get to and from places as this type of walking is usually more

utilitarian, for example, walking to the shops, walking to public transport or walking to work (Pikora et al., 2002; Saelens et al., 2003).

The hypotheses were:

1. At follow-up, changes in perceptions of environmental attributes will be associated with changes in walking behaviour.
2. The strength of the associations for changes in environmental perceptions will be stronger for neighbourhood, exercise walking and pleasure walking, compared to walking to get to and from places.

4.5.1 Characteristics of participants

The follow-up surveys were mailed eight weeks post baseline to the initial sample of 399. Completed surveys were received from 260 participants, resulting in a 65% response rate. The mean age of the sample was 61 years and comprised 39.3% men.

4.5.2 Measures

The perceived environmental attribute factors and the four walking measures used in the follow-up survey were the same as those used in the baseline survey. Additional items were used to measure the impact of the intervention. A complete copy of the follow-up survey is included in Appendix B-5.

Dose of Intervention. An additional variable ‘dose of intervention’ was computed for analyses of the follow-up data in order to measure the possible influence of the

intervention on walking (for the context of the study, see page xvii). The additional items in the survey measured how much of the intervention was recalled. The number of brochures recalled being received was added to the number of brochures they reported reading to give a rating of ‘dose’ of intervention. The maximum possible dose was six (three brochures received and read). The dose variable was then made dichotomous to create ‘high’ (4-6) and ‘low’ (0-3) doses of intervention.

4.5.3 Methods of analysis

Prospective analyses were mostly a replication of the analyses from the prospective study of Part 3, consisting of descriptive and bivariate analysis, followed by multivariate analyses using logistic regression.

In order to replicate the analyses conducted in the follow-up (prospective) study of Part 3 (Humpel, Marshall et al., in press), the *relative change* variable (proportional change scores) was again constructed for each of the four factors of perceived environmental attributes. This was computed by subtracting the follow-up scores from the baseline scores and then dividing by the baseline score, to give a proportional index of change relative to baseline perceptions. This variable was used in all logistic regression models.

4.6 Prospective Relationships of Change in Perceptions of Environmental

Attributes with Changes in Walking Behaviour: Outcomes

4.6.1 Bivariate relationships between changes in environmental perceptions, participant characteristics and changes in walking behaviour outcomes

For men, there was a significant increase in mean minutes of walking for exercise from baseline to follow-up, $t(1,98) = -2.34, p < .02$ (Table 4.8). For women, there was a significant increase in mean minutes of neighbourhood walking ($t[1,149] = -2.18, p < .03$) and for walking for exercise ($t[1,143] = -2.95, p < .004$). Slight increases in environmental perceptions were evidenced at follow-up although none of these were statistically significant (Table 4.8). No significant gender differences were found in baseline walking (all four outcomes) or for any of the four environmental attribute factors. At follow-up, there were no significant differences across the environmental and walking variables for gender.

There was no evidence of a relationship between ‘dose’ of intervention and changes in walking for all four walking outcomes. Intervention ‘dose’ was not a significant influence on changes in the four environmental perception factors. Furthermore, the effect of ‘dose’ was non-significant in all logistic regression analyses.

Table 4.8: Baseline and Follow-up Walking (minutes/week) and Perceptions Scores for Environmental Attributes for Men and Women.

	Men				Women			
	Baseline		Follow-up		Baseline		Follow-up	
	M	SD	M	SD	M	SD	M	SD
Minutes of walking								
Neighbourhood	202	168	196	117	175	133	194*	129
Exercise	140	140	170*	138	136	112	156*	117
Pleasure	24	44	34	66	34	66	47	77
To get places	35	48	42	59	32	48	40	62
Environment categories								
Perceived aesthetics	32.2	6.5	31.5	6.6	33.4	7.0	33.1	6.2
Perceived accessibility	50.0	16.0	51.6	15.5	51.5	16.7	52.4	17.9
Perceived safety	31.2	6.9	31.6	6.6	30.9	7.3	31.2	6.8
Perceived weather	24.6	8.6	25.4	8.6	24.7	8.7	25.5	9.2

* significantly different mean scores from baseline to follow-up

In bivariate analyses, baseline levels of environmental perceptions were found related to levels of participation in neighbourhood and exercise walking at follow-up (Table 4.9). Those participants who had initial high perceptions on all four environmental factors reported significantly more mean minutes of neighbourhood walking at follow-up compared to those reporting low perceptions. For example, those reporting high perceptions of the aesthetic appeal of the environment at baseline reported a mean 237 minutes of neighbourhood walking at follow-up. This was significantly more ($F(2,222) = 4.90, p < .005$) than those reporting low 'aesthetic' perceptions at baseline ($m = 171$ minutes). The result was similar for exercise walking, except for the environmental factor of 'aesthetics', where the same non-significant trend emerged.

Table 4.9: Mean Minutes (SD) of Follow-up Neighbourhood and Exercise Walking by Baseline Level for each Perceived Environmental Factor.

	Aesthetics	Accessibility	Safety	Weather
Neigh/hood				
Low	171 (100)	156 (99)	168 (97)	147 (108)
Moderate	194 (120)	174 (91)	180 (114)	171 (97)
High	237 (160)	248 (157)	248 (162)	251 (142)
	$F(2,222) = 4.90$ $p = .005$ $H > L$	$F(2,214) = 12.41$ $p < .000$ $H > L, M$	$F(2,242) = 8.95$ $p > .000$ $H > L, M$	$F(2,228) = 17.02$ $p < .000$ $H > L, M$
Exercise				
Low	142 (113)	136 (105)	130 (106)	119 (111)
Moderate	157 (135)	140 (103)	152 (128)	139 (108)
High	190 (126)	197 (145)	194 (131)	204 (131)
	Non-significant	$F(2,202) = 5.72$ $p = .004$ $H > L, M$	$F(2,227) = 4.98$ $p = .008$ $H > L$	$F(2,213) = 10.92$ $p < .000$ $H > L, M$

H - high; M - moderate; L - low

Table 4.10: Follow-up Mean Minutes of Walking by Gender and Location

	Men		Women	
	Non-coastal	Coastal	Non-coastal	Coastal
Minutes walking				
Neighbourhood	176 (138)	216 (136)	153 (126)	206 (128)*
Exercise	173 (150)	171 (132)	97 (103)	172 (117)*
Pleasure	25 (62)	37 (66)	45 (94)	50 (77)
To get to places	45 (67)	39 (55)	37 (57)	40 (63)

* significant differences in mean minutes of walking

Place of residence. At follow-up, men living in a coastal location reported more minutes of neighbourhood and pleasure walking, but less minutes of exercise walking and walking to get to and from places than men who lived in a non-coastal location (Table 4.10), although these results for men were non-significant. Women living in a coastal location reported significantly more minutes of neighbourhood walking ($F(1,151)= 4.97, p<.027$) and significantly more minutes of walking for exercise ($F(1,144)= 12.11, p<.001$) than did women living in a non-coastal location. They also reported more minutes of pleasure walking and walking to get to places but these results were non-significant.

4.6.2 Multivariate analyses: predictors of walking behaviours

Although few significant gender differences had been found in bivariate analyses, logistic regression analyses stratified by gender were conducted as planned. All logistic regression models included age, education, dose of intervention, location and the four *relative change* environmental perception factors. The models examined

whether an increase in perceptions of the neighbourhood environment over time was associated with any increase in the four walking outcomes. No evidence was found to support any of the hypothesised relationships proposed in Section 4.2 (Table 4.11).

The findings do not support *Hypothesis 1*, which states that at follow-up, a change in perceptions of the environment will be associated with a change in walking behaviour.

Neither was there any support for *Hypothesis 2*, that the strength of the associations for changes in environmental perceptions will be stronger for neighbourhood, exercise walking and pleasure walking compared to walking to get to places. An increase in perception of the neighbourhood environment was not found to be associated with an increase in walking for any of the purported reasons. The findings for any increase in neighbourhood, exercise and pleasure walking are reported in Table 4.11 for comparative purposes with the results from the prospective study of Part 3 (section 3.5).

At a multivariate analysis level, participants' baseline levels of environmental perceptions were not significantly related to changes in neighbourhood or exercise walking at follow-up.

Table 4.11: Odds ratios (95%CI) for Changes in Perceptions of Neighbourhood Environmental Attributes and Their Association with an Increase in Walking Behaviour Among Men and Women

	MEN			WOMEN		
	Any increase in n'hood walking	Any increase in exercise walking	Any increase in n'hood walking	Any increase in exercise walking	Any increase in n'hood walking	Any increase in pleasure walking
Change in perception of aesthetics						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	0.77 (0.13-4.55)	1.40 (0.26-7.60)	1.41 (0.26-7.82)	1.05 (0.38-2.90)	1.18 (0.40-3.48)	2.98 (0.87-10.15)
Change in perception of accessibility						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.20 (0.28-5.08)	2.63 (0.62-11.16)	1.59 (0.36-7.15)	1.25 (0.48-3.24)	0.96 (0.35-2.66)	2.95 (0.92-9.42)
Change in perception of safety						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.29 (0.30-5.65)	0.50 (0.12-2.06)	0.84 (0.19-3.78)	1.39 (0.47-4.16)	1.07 (0.33-3.42)	0.54 (0.15-2.01)
Change in perception of weather						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	0.31 (0.60-1.58)	0.61 (0.12-2.06)	0.60 (0.12-3.15)	0.92 (0.32-2.62)	2.02 (0.66-6.22)	0.70 (0.20-2.42)
Location						
Non-coastal	1.00	1.00	1.00	1.00	1.00	1.00
Coastal	3.07 (0.40-23.54)	1.11 (0.23-5.48)	0.90 (0.17-4.83)	1.10 (0.38-3.17)	5.48 (1.56-19.34)	3.48 (0.81-15.00)

4.6.3 Summary of the findings of the prospective study

The prospective study examined the relationship between changes in an extended set of environmental perceptions (statistically grouped as factors), with changes in neighbourhood walking, exercise walking, walking for pleasure and to get to and from places. Baseline perceptions were found to be associated with follow-up levels of walking in bivariate analysis. Those with the most positive perceptions initially, were found to have the greatest increase in walking across all four walking outcomes. This relationship did not remain when examining the relationships at a multivariate level. Changes in perceptions of the neighbourhood environment over time were not found to be associated with changes in walking. Men significantly increased their mean minutes of walking for exercise, and women significantly increased their mean minutes of neighbourhood walking and exercise walking, but the changes in environmental perceptions were not found to be associated with the changes in walking behaviour.

There was evidence on the importance of coastal versus non-coastal location. At follow-up, both men and women who lived in a coastal location generally spent more minutes walking for all four walking types.

4.7 Limitations of the Studies Reported in Part 4

A limitation of the studies from Part 4 was that the data were collected from participants who were part of an intervention trial. It is possible that the intervention context may have exerted some influence on people reframing their perceptions. An

attempt to control for the effect of the intervention was employed by entering the variable ‘dose’ of intervention into the logistic regression models.

Self-report mailed surveys were used in the studies of Part 4, and as such these data may be subject to biasing influences. The participant’s ability to complete the survey may have been limited by the ability to read English, and they also need an understanding of the terms used. Surveys need to be designed with careful wording and be sensitive to age, cultural and ethnic differences (Aday, 1996).

A further limitation of the studies from Part 4 is the potential for cognitive overlap in the reporting of walking for different purposes. Participants may have unintentionally overstated their levels of walking with this multiple measurement of walking format. Reported exercise walking could also have included any neighbourhood walking and neighbourhood walking could have included some walking to get to and from places.

Test-retest reliability was not conducted for the new environmental attribute items. Factor analysis of the items was conducted. This provided evidence of construct validity to the measures. The reported internal consistency within the factors was good (section 4.4.1).

4.8 Implications of the Studies

The relationships found between changes in perceptions of environmental attribute and changes in walking behaviours in this study differed from the findings for the prospective workplace study of Part 3. The prior findings were not replicated in this prospective study. This may be due to a number of important differences between the

samples of Parts 3 and 4. A self-completion measurement format was used in the studies of Part 4 compared to the use of trained interviewers in the studies Part 3, and the participants were mainly of an older age group in Part 4. These and further differences are dealt with fully in Part 5.

PART 5

DISCUSSION

This section summarises the findings from Parts 3 and 4 and discusses their main limitations. The implications of the findings and recommendations for future research are discussed. Implications for the promotion of physical activity and public health practice and policy are considered.

5.1 Overview of Findings

The cross-sectional study of Part 3 (sections 3.2 to 3.4) examined associations of perceived environmental attributes and ‘coastal place of residence’ with walking and general physical activity behaviour. The study found evidence of relationships between the environmental attributes and physical activity, especially for the specific behaviour of neighbourhood walking. The results give support to previous findings from two Australian studies: the perceived environment domains of ‘aesthetics’ and ‘convenience’ were associated with walking for exercise and recreation (Ball, Bauman et al., 2001); and, the perceived domains of ‘aesthetics’ and ‘practical’ (similar to accessibility) environment were found to be associated with walking more than two hours a week (Carnegie et al., 2002). The present study found these relationships for men only. These previous studies did not examine gender differences in their findings. The finding also gave support to a previous Australian study (Bauman et al., 1999) that found coastal residents are more active than non-coastal residents.

The specific measure of physical activity behaviour (neighbourhood walking) was found to exhibit the strongest relationships with physical environment attributes, as have been proposed by environmental models (Owen et al., 2000; Sallis & Owen, 2002). Different aspects and settings of the physical environment may influence different types of activity behaviour. By focusing in on a particular behaviour, a picture emerged of which environment-physical activity relationships were more important. The physical environment, and its influence on physical activity may occur at too many levels to allow for a composite measurement such as total physical activity to be sensitive to these relationships.

A strength of the cross-sectional study was the testing of associations while adjusting for the other environmental variables in multivariate analyses. Significant relationships emerged for all five environmental attribute variables with men in a model in which the other environmental attributes, and demographics were controlled for.

The prospective study reported in Part 3 (sections 3.5 to 3.7) is the first to examine the associations of changes in environmental perceptions with changes in walking behaviour. The study found that environmental perceptions did change over time and that they were related to changes in walking behaviour. The changes in perceptions of environmental attributes did occur over a relatively short ten-week time period, and it is not known whether the changes would be maintained if measured over a longer time period. If the changes in perceptions of 'aesthetics' and 'convenience' were to be maintained over the longer term, and were associated with sustained increases in walking, then these factors would be more likely to be acting as causal influences.

As the relationships between the environment and the physical activity can be reciprocal (Bandura, 2000; King et al., 2002), it is possible that those who began to do more walking began to more accurately perceive their environment, thus leading to the relationships that we have reported. Future prospective studies need to take measurement at more time points than baseline and follow-up, in order to gain a clearer view of the direction of the relationships.

The findings from this first prospective study do not demonstrate a cause-effect relationship, but they do add to the accumulating evidence (Humpel et al., 2002) that there are significant relationships between people's perceptions of their environments and their physical activity behaviours. A larger quantity of evidence is required, particularly from studies that experimentally manipulate environmental-perception variables and from 'natural experiments' in which people are exposed, prospectively, to environmental changes. Previous studies (DeBourdeauhuij et al., 2002; Sallis, Hovell, & Hofstetter, 1992), have found that changes in psychosocial variables were more powerful correlates of exercise than static baseline measures. Interestingly, the prospective study of Part 3 found changes in environmental perceptions also had stronger associations with follow-up walking compared to the baseline variables.

The differences in the findings in Part 3 for men and women emphasise the need to carry out gender-specific analyses in physical activity studies (Sallis, Hovell, & Hofstetter, 1992). An increase in positive perceptions of the environment was found to be associated with increased walking for men but less so for women. The direction of association was found to be different for men and women for some of the environmental attribute variables. In the prospective study, positive changes in

perceptions of ‘traffic’ not being a problem were negatively associated with an increase in walking for men, and positively associated with an increase in walking for women. This result for ‘traffic’ also emphasises the need for further research on the items used to measure environmental perceptions. This specific environmental factor needs further examination; perhaps using multiple items to assess this variable, as only one item was used in this study.

The studies of Part 4 aimed to replicate the environment-behaviour relationship findings of Part 3 in a broader community sample implementing a greater range of environmental attribute items. Part 4 also extended on Part 3 by using statistical methods to identify coherent subscales amongst the environmental attribute items. The studies also further tested the proposal for behaviour-specific models by using a greater range of differentiated walking outcomes.

The cross-sectional study reported in Part 4 (sections 4.3 to 4.4) found significant associations between the environmental attribute factors and walking and that different environmental factors were related to different walking outcomes. Weather proved to be the environmental factor that evidenced the strongest relationships with walking for both men and women. Although the weather is often reported as a barrier to physical activity, few studies have examined this variable using multivariate models. This issue needs to be explored in future studies. If the strong result for perceptions about the influence of the weather can be generalised to other samples, this will have implications for the promotion of physical activity. In this study, odds ratios ranged from 4.7 to 5.4 for men and 3.8 to 7.6 for women (see Tables 4.6 and 4.7). This ‘determinant’ is not modifiable, although individual perceptions about the

influence of weather may be. To address this factor, interventions may need to be more attentive to encouraging, for example, appropriate clothing when undertaking activity.

Safety did not prove to be an important influence on neighbourhood or exercise walking for the sample of adults in the studies reported in Part 4. Safety was not associated with neighbourhood or exercise walking in men, but men who perceived their environment as safest were less likely to walk for pleasure. Perhaps by not walking for pleasure, these men have not been in the position to think about their neighbourhood in terms of its safety. Humpel et al. (2002) also found safety demonstrated few associations with physical activity.

Significant associations of age with walking for pleasure were found for both men and women. But contrary to what might be expected, those over 60 years of age were less likely to walk for pleasure. It may be that around retirement age and older, walking may be perceived as being more for the purposes of exercise and for health reasons. This may be related to advice given by general practitioners to older adults about the need to be more active for health benefits.

None of the environmental attributes were found to be associated with walking to get to and from places. Walking to get to and from places was found to be less related to perceptions about the environment compared to walking by choice, that is, for exercise or pleasure. This supports Saelens and colleagues ecological model of neighbourhood environment influence on walking and cycling (Saelens et al., 2003). This model proposes that some environmental attributes will have stronger relations

with walking for transport, while other environmental attributes will demonstrate stronger relations with walking for exercise or recreation.

The results for the prospective study reported in Part 4 (sections 4.5 to 4.7) were not as expected, in that at the multivariate analysis level they did not give support to previous findings. In Part 3 changes in environmental perceptions were found associated with changes in walking behaviour. This relationship was not evidenced in the prospective study of Part 4. An expanded scale was used to measure environmental perceptions and the items may not have been sensitive enough to assess any changes in the environmental attributes and their association with changes in walking.

There were important differences between the workplace sample of Part 3 and the community sample of Part 4 that may, in part, explain the differences in findings.

- (1) The workplace sample had a mean age of 43 years whereas the community sample had a mean age of 60 years. Older adults may walk for different reasons and be influenced by different aspects of the environment compared to younger adults. With a mean age of 60 years, the community sample would have had a large component of retired people, with more time available and perhaps different priorities. Future studies using an older sample should include an item asking about employment or retirement status.
- (2) A larger proportion of the community sample was women (57%) versus in the workplace sample (49.8%). Less strong relationships were found for women in all the studies of this thesis. Having a larger proportion of women may have resulted in less significant relationships emerge in the community sample.

- (3) The workplace sample had a higher overall level of education with 53% academics as opposed to 23% of the community sample reporting tertiary education. Those with greater education levels have been shown to be more likely to participate in physical activity (Trost et al., 2002; USDHHS, 1996).
- (4) The workplace sample was larger ($n = 800$) compared to the community sample ($n = 399$). A larger sample size may have given the workplace study greater power to detect associations.
- (5) The method of assessment was different in the two studies. The workplace sample was assessed by telephone interview whereas, due to funding limitations, the community sample was assessed by a mail survey. The different modes of assessment may have had a confounding effect. During telephone interviews, participants were able to have clarified any questions they did not understand.

The inconsistent results from the two prospective studies make it difficult to draw any definite conclusions about longer term, environment-behaviour relationships. Over time, the workplace sample of Part 3 reported changes in environmental perceptions that were related to changes in neighbourhood walking, whereas for the community sample of Part 4, no relationship was evidenced for neighbourhood walking or the other walking outcomes. Whether perceptions of environmental attributes are 'trait-like' or amenable to change remains unclear. The dissimilarity of findings could be due to the above listed differences between the samples, or they could be due to the features of the environment that were examined in the studies. Further research is needed with different samples from different geographical settings. The studies of this thesis are a starting point, a basis for future research to build upon.

While it was possible to replicate the association of coastal place of residence with physical activity (Bauman et al., 1999) to some degree in all four studies, the reasons for the association remain to be elucidated. Attributes of the coastal settings, such as availability of beaches, open space recreational areas and the overall aesthetically pleasing qualities, may positively influence participation in walking. Alternatively, the coastal location could simply be the preferred location of residence for those who are more active (Bauman et al., 1999).

The finding that different aspects of the environment were found related to different walking behaviours is important (see Table 5.1). This lends support to the proposal that behaviour-specific ecological models are needed (Owen et al., 2000; Sallis & Owen, 2002). An implication of these studies might be that when developing interventions to increase physical activity, different environmental characteristics may need to be considered depending on the type of physical activity behaviour the program is targeting. Thus, if a program was targeting an increase in walking, the aesthetic environment and the proximity of trails and cycle paths for walking need to be targeted for walking for exercise; whereas footpaths and shops within walking distance may be more important to target for walking to get to and from places. It will be important to continue to examine which particular environmental attributes are more relevant to which particular physical activity behaviours.

Table 5.1: Summary of the Significant Associations from the Cross-Sectional Studies for each Environmental Category with Neighbourhood Walking, Exercise Walking, Walking for Pleasure and Walking to Get to and From Places.

	Part 3		Part 4	
	Men	Women	Men	Women
Aesthetics (parts 3 & 4)	N'hood (+)		N'hood (+) Exercise (+)	
Convenience (part 3)	N'hood (+) Total PA (+)	N'hood (+)	N'hood	
Access to services (part 3)	N'hood (+) Total (+)	N'hood (-) Total (+)		
Traffic (part 3)	N'hood (-)			
Accessibility (part 4)			N'hood (-)	Pleasure (+)
Safety (part 4)			Pleasure (-)	
Weather (part 4)			N'hood (+) Exercise (+)	N'hood (+) Exercise (+)
Location (parts 3 & 4)	N'hood (+)		N'hood (+)	

Total – total walking; PA – physical activity; N'hood – neighbourhood walking

From the studies of this thesis, significant positive relationships with neighbourhood walking for both men and women were found with the environmental attributes categories or factors of 'aesthetic' appeal of the environment, 'convenience' of facilities for walking and the 'weather' not being an influence (Table 5.1). 'Traffic' as

a problem exhibited a negative relationship with neighbourhood walking for men, but a positive relationship with *change* in walking for women. ‘Access’ to services was positively related to walking for men and negatively for women. As previously stated, the mixed directions of association emphasise that further work is needed on both refining the measures of environmental perceptions and the need for gender specific analyses. Even so, the pattern of findings that emerged, demonstrate that the attributes of the environment that are under examination as potential environmental influences on walking are of relevance.

5.2 Limitations of the Studies

The limitations of the studies have been reported in detail in the appropriate sections of each Part (sections 2.5, 3.8 and 4.8). The main limitations were: First, the context of the studies. Both the workplace and community studies were set within the context of intervention trials. Although the influence of the intervention was controlled for in statistical analyses using the variable ‘dose’ of intervention, it cannot be ruled out as a factor that might have acted to confound the relevant relationships.

Second, the majority of the participants in the samples of the studies of this thesis resided in the Illawarra region, the geographical nature of this district resulted in a limited variation in the environment, and this may limit the generalisability of the results to other geographical settings.

Third, the cross-sectional design of two of the studies limits the conclusions that can be drawn. The two prospective studies, while more powerful in design than a cross-sectional design, still do not allow for causal relationships to be inferred.

Fourth, all data were collected via self-report telephone interview or by a mailed self-report survey. Self-report measures may have high levels of measurement error.

Recalling and reporting physical activity is a complex task and can result in over or under reporting of the duration and/or frequency of the activity. Subjective perceptions are important to measure and as they are a psychological construct, there is no option but to measure by self-report. An additional measurement limitation of the studies from Part 4 is the potential for cognitive overlap in the reporting of walking for different purposes. Participants may have unintentionally overstated their levels of walking with this multiple measurement of walking format.

Fifth, the generalisability of results from the workplace studies of Part 3 is limited due to the education level of the study sample. Higher education levels have been shown to be related to higher levels of physical activity participation (Owen & Bauman, 1992; USDHHS, 1996).

Sixth, the time frame for both prospective studies was relatively short; ten weeks for the workplace study of Part 3 and eight weeks for the community study of Part 4. This may have limited or disguised relationships that may be found over a longer time period.

5.3 Implications: Future Research Directions

Measurement of the influence of the physical environment on physical activity participation is still at an early stage. Of the twenty-four items used to measure perceptions of environmental attributes in Part 4, the reliability of only eight items had previously been examined (Humpel, Marshall et al., in press). The perceived environmental measures used may have been too inaccurate, or not sensitive enough to detect significant changes in perceptions, or to detect associations with changes in walking (Sallis et al., 1997). However, internal consistency scores were good for each factor. Further studies are needed on the measurement properties; the reliability and validity of this perceived-environment scale. The development of valid and reliable environmental perception scales is needed because they are not expensive and they can easily be included in a greater number of studies thus evaluating the influence of the environment in a variety of locations and populations (Saelens et al., in press).

Due to the probably inexact nature of current self-report measures of the environment, there has been a move in the field towards a greater use of objectively verifiable measures of the physical environment. Objective measures of attributes of the environment are not susceptible to unreliable recall or subjective bias. Studies are beginning to investigate the use of variables derived from Geographical Information Systems (GIS) for linking physical environment data with epidemiological and behavioural studies datasets to test hypotheses about the physical environment-behaviour relationship (Giles-Corti & Donovan, 2002a, 2002b; Saelens et al., in press; Troped et al., 2001). Including GIS derived variables can help overcome some of the methodological problems associated with reliance on self-report environmental

factors. The use of GIS data can help identify relationships between people's local community environments and their level of physical activity, but not people's perceptions about the community environment. Information about variables such as residential density, street connectivity, and the locations of features like parks in relation to people's homes can be linked together with survey data on demographics and physical activity behaviour (Saelens et al., 2003).

Future studies need to compare results from both self-report and objectively-measured environmental attributes. If strong patterns of concordance are found between the two methods of measurement, then this will provide support for the validity of self-report perceptions of the environment used in the studies of this thesis and those of others.

The problems associated with self-report measures of physical activity have encouraged the use of measures of absolute amounts of physical activity like pedometers and accelerometers in studies, although few studies have evaluated the use of these against self-report measures for adults (Sallis & Saelens, 2000). Future studies need to use a combination of self-report and objectively measured physical activity for maximum accuracy. Walking in particular lends itself to easy evaluation with an objective measure like a pedometer and would thus help validate self-report measures. If budgetary constraints allow, this would be an ideal measurement addition to walking studies. Self-report physical activity is still important to collect in order to gain knowledge of the context and type of physical activities occurring that cannot be recorded with the current objective measures.

This thesis argued (Section 1.3) that there are limitations to social cognitive models that emphasise individual-level attributes, in the context of population health strategies. Because social-cognitive models have been a predominant influence on behavioural studies of physical activity (Bauman et al., 2002; Godin, 1994; Trost et al., 2002), the field has been shaped by assumptions that choices to be active or inactive are conscious, deliberate choices – a consequence of attitudes, intentions, self-efficacy and other cognitive mediators of behavioural change (Sallis & Owen, 1999). This thesis emphasised the call for an ecological approach in health behaviour research. The inclusion and focus on the physical environment is a key feature of ecological models of health behaviour. Ecological models posit multiple levels of factors are involved, and there is a need to understand how psychological, social and policy and environment all interact to influence physical activity behaviour.

This thesis has overall, given support to the importance of examining the influence of environmental factors on adults' walking behaviour. If we are to conclude that environmental attributes play a role in people's participation in physical activity, we need to now go beyond looking at environmental attributes on their own, and include the strongest individual factors (for instance self-efficacy), and the role of the social environment (for instance social support) in future prospective studies (Giles-Corti & Donovan, 2002a).

Studies have found a range of variables from all three domains, psychological, social and environmental, that are linked with physical activity behaviour. If research now moves on to multiple level studies, an important question will be 'which are the most important ones?' One team of researchers has examined the relative influence of

individual, social and environmental factors with physical activity and the specific behaviour of walking (Giles-Corti & Donovan, 2002a, in press). They found that after adjustment for demographic variables the relative influence of the three factors to be almost equally important in relation to walking. To increase walking and other physical activity behaviours, future intervention programs may need a comprehensive strategy that attends to the psychological, social and physical environments.

Multiple-level studies involve the use of advanced statistical methods (Masse, Dassa, Gauvin, Giles-Corti, & Motl, 2002), and take into account the role of possible mediators (intervening variables) and moderators (effect modifiers) in the complex causal relationship model (Bauman et al., 2002; Blakely & Woodward, 2000; King et al., 2002). There will need to be increasing focus on theory, study design and examining of sources of error (Blakely & Woodward, 2000). For example, a mediator is on the causal pathway between an intervention program and the program's outcome or effect. The mediator (for example, self-efficacy for activity) may partially explain the strong effect or lack of effect of an intervention on the activity level of the individual. Future studies may find that *perceptions* of the physical environment are mediators of the effect of the objective physical environment (what is actually out there - walking trails, parks, beaches) and levels of participation in walking.

Past physical activity media campaigns have focused on the use of direct modelling, influencing awareness and knowledge of health benefits, to try to prompt an increase in walking behaviours (Bauman, Bellew, Owen, & Vita, 2001; Marcus, Emmons et al., 1998; Marcus, Owen, Forsyth, Cavill, & Fridinger, 1998; Sallis et al., 1998). A possibility for inclusion in future interventions to promote increased activity is to

attempt to change peoples' perceptions of the environmental contexts for activity. Environmentally focussed interventions could be aimed at drawing participants' attention to cues for activity in a specific setting (Owen et al., 2000); for example, their local neighbourhood environment. An intervention aimed at influencing people's *perceptions* of the environment, may shed light on the possibility of targeting awareness of the environmental context and cues as well as focussing on the behaviour itself in interventions.

This will become increasingly relevant, as environment and policy changes lead to more opportunities for activity and community settings become more amenable to activity (eg, more paths, cycleways, attractive landscaping). It may be necessary to persuade people to change their habitual 'automatic' way of thinking about the environment as a precursor to trying to change their behaviour. This will require the reinforcing of positive perceptions they may already have about the environment, and prompting and encouraging changes to negative perceptions.

A body of evidence (previously discussed in section 1.3.3) already exists that contends environmental influences can play a direct role in habitual behavioural choices (Bargh, 1997; Bargh & Chartrand, 1999; Bargh & Ferguson, 2000).

Bargh and colleagues identify circumstances in which direct environmental influences can be a more important determinant of a behavioural choice than the predominant approach of cognitively mediated influences. Features of current environments (people, objects, settings in particular) can drive much behaviour as 'automatic', without mediation by conscious reflection on a decision about behaviour. The authors

posit that non-conscious mental systems perform a large part of every day behaviours automatically and this could include behaviours like physical activity. Refining of the measurement of perceptions of the environment, and more studies to determine which factors are the most influential are required before it is possible to consider interventions attempting to change habitual thought patterns with regards to physical activity behaviour.

Future studies need to ask about people's preferences for 'settings' for physical activity. If a person's preferred activity is swimming (pool, beach), or aerobic classes (at a gym), then perceptions about the neighbourhood environment may not be important as this is not their choice of environment for activity.

In the future, conducting research on environmental relationships with walking and other physical activity behaviours will require the collaboration of a wider range of disciplines than has been previously involved (King et al., 2002). As well as links with geographers with the use of GIS databases, there will likely be some convergence of urban planning and transportation professionals with behavioural research. Transport and planning research supports links of the environment with physical activity in the form of walking or cycling for transport. A strength of the transportation research is examining the relationships of objective environmental measures like land use, census data, housing density and land use with walking and cycling (Saelens et al., 2003). These different perspectives have the potential to broaden the understanding of influences on physical activity.

5.4 Implications: Public Health Policy and Practice

Regular participation in moderate-intensity activity like walking, is associated with health benefits (Pate et al., 1995; Thune & Furberg, 2001; USDHHS, 1996). Walking can be done for exercise, recreation, as part of a person's work and as transport to get to and from places. Therefore, walking offers an important means of increasing population levels of physical activity and maintaining health. In older age groups, a larger proportion than in the younger age groups are reporting walking for exercise already (Bauman, Owen, & Leslie, 2000). Older adults in particular, may be amenable to intervention aimed at increasing their walking levels to meet the current guidelines.

While research on environmental-behaviour relationships is still at an early stage of development (Humpel et al., 2002; King et al., 1995; King et al., 2002; Saelens et al., 2003), it has some potentially important public health implications. Future public health approaches to increasing physical activity need to consider strategies that focus on the importance of particular attributes of the local environments that may impact on particular physical activity behaviours like walking. These strategies may have more impact than, for example, mass media campaigns that have demonstrated a limited capacity to influence activity levels (Bauman, Armstrong, Davies, Owen, Brown, Bellew, et al., 2003).

A walkable, aesthetically pleasing environment is likely to be an important influence on general health and wellbeing. For example, a recent study from Japan found that living in areas with walkable green public open spaces (such as parks and tree lined streets) was a significant predictor of longevity among residents of a large city,

independent of known demographic influences (Takano, Nakamura, & Watanabe, 2002). From a public health perspective, a better understanding of environmental determinants of walking is an important domain of research.

Interventions to increase physical activity designed with a focus on the physical environment hold particular potential because they are intended to influence large groups or whole communities. As discussed above, an intervention targeting an increase in walking could include strategies such as the building of new footpaths and walking trails (facilities); the planting of trees for shade and to beautify the local environment (aesthetics). This could then be followed by an educational campaign promoting awareness of the facilities that are available; drawing attention to 'cues' for activity in the environment. It is important to have the environmental intervention in place before awareness and education campaigns are attempted (Sallis et al., 1998).

Changes in policy will be required to increase land zoned as recreational open space and to make available funds for the building of suitable facilities supportive of physical activity. In order for these changes in policy to happen, widespread support from the general public and key leaders will be necessary (Baker et al., 2000). This again brings in the importance of multi-disciplinary collaboration, as urban and neighbourhood planners should be targeted to consider incorporating spaces for physical activity in the development plans of future communities.

Public health research may be coming to the end of an era that has focussed on risk factors for disease only at an individual level (Susser & Susser, 1996). It has been argued that the dominant paradigm is being displaced by a new one, a new era,

moving beyond the level of individual characteristics to one of being equally concerned with causal pathways at the societal and environmental level (Susser & Susser, 1996; Marmot & Wilkinson, 2000). As research progresses, the influence of the physical environment may, or may not, prove to be a primary determinant of active or inactive choices. There is a strong existing body of evidence supporting the influence of psychological factors such as self-efficacy, attitudes, intentions, and social support (Dishman, 1990; Dishman et al., 1985; Sallis & Owen, 1999; Trost et al., 2002).

Even if small amounts of variance in physical activity are explained by the influence of environmental variables, the fact that whole communities are impacted by any change to make the environment more supportive of physical activity is important. The many small effects across communities could accumulate to mean substantial physical activity changes across whole populations. Having a supportive environment to provide opportunities for walking and other physical activity behaviours would seem a necessary precursor to any actual behaviour change.

If developing a supportive physical environment can be shown to increase participation in walking at a neighbourhood or community level, this may help to lower prevalence rates of inactivity at a population level. Lower levels of inactivity will in turn, have a protective effect and help to reduce the population risk for many of the chronic diseases found in today's sedentary societies.

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APPENDIX A:

Published papers associated with this thesis

A-1

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine*, 22(3), 188-199.

A-2

Humpel, N., Owen, N., Leslie, E., Marshall, A., Bauman, A., & Sallis, J. F. (in press). Associations of location and perceived environmental attributes with walking in neighborhoods. *American Journal of Health Promotion*.

A-3

Humpel, N., Marshall, A., Leslie, E., Bauman, A., & Owen, N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*.

APPENDIX A-1

Humpel, N., Owen, N., & Leslie, E. (2002). Environmental factors associated with adults' participation in physical activity: a review. *American Journal of Preventive Medicine*, 22(3), 188-199.

Environmental Factors Associated with Adults' Participation in Physical Activity

A Review

Nancy Humpel, BPsyc, Neville Owen, PhD, Eva Leslie, MHN

Background: Promoting physical activity is a public health priority, and changes in the environmental contexts of adults' activity choices are believed to be crucial. However, of the factors associated with physical activity, environmental influences are among the least understood.

Method: Using journal scans and computerized literature database searches, we identified 19 quantitative studies that assessed the relationships with physical activity behavior of perceived and objectively determined physical environment attributes. Findings were categorized into those examining five categories: accessibility of facilities, opportunities for activity, weather, safety, and aesthetic attributes.

Results: Accessibility, opportunities, and aesthetic attributes had significant associations with physical activity. Weather and safety showed less-strong relationships. Where studies pooled different categories to create composite variables, the associations were less likely to be statistically significant.

Conclusions: Physical environment factors have consistent associations with physical activity behavior. Further development of ecologic and environmental models, together with behavior-specific and context-specific measurement strategies, should help in further understanding of these associations. Prospective studies are required to identify possible causal relationships.

Medical Subject Headings (MeSH): environment; exercise; preventive medicine and public health; public facilities; public policy (Am J Prev Med 2002;22(3):188-199) © 2002 American Journal of Preventive Medicine

Introductions

Regular physical activity is strongly associated with better physical and psychological health outcomes, and the promotion of physical activity is now a high public health priority.¹ To develop relevant policies and effective interventions, it is necessary to identify the factors that can be changed to influence physical activity behavior.² Such factors have been classified within seven domains: demographic and biological, psychological, cognitive and emotional, behavioral attributes and skills, social and cultural, physical environmental, and physical activity characteristics (perceived effort and intensity).^{2,3} Within these classes of factors, physical environment attributes are a new topic of research interest⁴ and are being addressed by

policymakers and program providers.⁵ However, environmental attributes are among the least understood of the known influences on physical activity. Their conceptualization and measurement comprise a relatively new area of research.^{5,6}

Applications of health behavior theories to physical activity have identified roles for environmental influences, most often in terms of "barriers," "facilitating conditions," or "contextual influences."⁷ Bandura's⁸ social cognitive theory provides an account of the interactions of environmental, personal, and behavioral factors. The relative influence exerted by these three sets of interacting factors varies for different activities, different individuals, and different circumstances. Bandura argues that when environmental attributes exercise powerful constraints on behavior, they emerge as the over-riding determinants. Environmental attributes, in the case of physical activity, may be particularly influential.

Sallis and Hovell⁹ developed a social cognitive model of physical activity behavior, emphasizing the role of environmental attributes, within a context where multiple determinants interact at several levels. "Ecologi-

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cal" models of health behavior provide accounts of the interaction of people with multiple levels of determinants within their physical and sociocultural environments.^{10,11} Given the inherent complexities of ecologic frameworks, behavior-specific models have been proposed.^{4,6} Applied to physical activity,⁴⁻⁶ such models aim to provide an integrated account of the complex patterns of possible determinants.

A central focus of ecologic models is the role of the physical environment, recognizing that environments themselves and people's behavior within them are shaped by social and organizational influences. In this regard, the "behavior settings" construct¹² is helpful, highlighting how physical activity can be promoted or encouraged within some environments, while made more difficult or restricted in others.^{4,6} Conceptual models to account for the influence of environmental factors on physical activity should be particularly helpful in the new public health context for physical activity, within which environmental and policy interventions are being developed and implemented.^{5,13}

In new and emerging fields of preventive medicine and public health, models that help to explain behavior-environment relationships can play a key role in shaping the research agenda and in linking research, policy, and practice. However, in order to assess the utility of these models, the key dimensions that they identify must be measurable. While the measurement of physical activity behavior is now a well-established field, this is not the case for the measurement of physical activity environments.^{4,5} Given the rapidly developing focus in research, public policy, and practice on the role of environmental attributes in determining physical activity participation, there is the need for high-quality empirical evidence supporting environment-behavior relationships. In this context, there is a particular need to examine how environmental factors that may influence physical activity can best be assessed.

We reviewed the findings of quantitative studies examining the associations of particular environmental attributes with physical activity behaviors. Our focus was on studies of adults. Our aim was to provide a systematic overview of the measures that have been used to assess environmental attributes and to review the patterns of environment-behavior associations that have thus far been identified.

Methods

Our primary inclusion criterion was relationships between particular physical environment attributes and physical activity behaviors. Only studies that assessed some physical activity behavior or behaviors as an outcome variable or variables were included. Specific items within the assessment instruments from each study that related to the physical environ-

ment were, where possible, extracted for the purposes of this review. If a theory or construct was mentioned as guiding the study, this was noted. The specific type of physical activity behavior measured in each study was identified and, if available, the specific setting in which the behavior occurred.

Computerized searches of Psychinfo, Medline, and Cinahl were conducted in the English-language literature, using the following search terms: physical activity, exercise, environment, environmental determinants, physical environment, facilities, convenience, barriers, constraints, recreation, behavioral context, inactivity, situational factors, neighborhood, recreation, and safety.

Studies initially identified by using the search criteria totaled 33. Studies were excluded from further consideration if they were qualitative only; if they were solely descriptive in nature (e.g., reporting only frequencies of an environmental barrier); or if the physical environment items (perceived and objective) of the study could not be disentangled from psychological or social barrier items (primarily cases in which only composite scores were reported). Only those studies that measured environmental variables that could be related individually and directly to measured physical activity variables were retained. An exception was made for cases in which a small number of items assessing closely related attributes were combined; the derived variable was included in our review.

The items dealing with environmental attributes that were extracted from the papers identified in our searches were categorized by logically plausible groupings of similar items. At this early stage of research on the associations of environmental attributes with physical activity behavior, this is most appropriately a descriptive integration, rather than a theoretically based synthesis. Social cognitive theory and ecologic models point to environmental factors as potentially important influences on health-related behaviors. However, measures of environmental attributes can be seen as reflecting, only in a very broad sense, the "environmental" construct within these conceptual models. Thus, we did not attempt, formally and specifically, to identify links of the environmental variables that were measured in the studies with particular theories or specific constructs. Where studies did identify a theoretical basis or bases for their approach, this is noted in the narrative text accompanying our tables.

Results

Using the above criteria, we identified 19 studies, of which 16 examined the relationship between the perceived physical environments and physical activity.¹⁴⁻²⁹ Four of the studies used objective measures of the environment, including place of residence (using postal codes), physical distance, and accessibility of facilities.²⁹⁻³² One study included both perceived and objective measures.²⁹ Twelve of the 19 studies identified an explicit theoretical basis to their research. Only one study¹⁴ reported prospective data on the relationship of environmental variables to physical activity change.

Some studies assessed perceptions of generally de-

See related Commentary on page 208.

defined "barriers" to starting or increasing physical activity.¹⁵⁻¹⁸ Others included barrier items along with items related to the existence and characteristics of physical facilities in the environment, such as the fact that they existed in participants' neighborhood or home environment or that such facilities were conveniently located.^{18-24,29}

Studies Using Self-Report Measures of Environmental Attributes

Table 1 presents the final selection of quantitative studies examining the relationship between self-report environmental factors and physical activity among adults. For each paper, the environmental items are reported along with the scale used. The type of physical activity behavior measured (and in parentheses, the specific outcome variable used in the analysis where that was different from the behavior measured) is listed. Where reported, the setting of the study is described.

The earliest self-report study identified (reported by Sallis et al.¹⁹ in 1989) examined the cross-sectional relationships of variables reflecting constructs from social learning theory (self-efficacy, modeling, and family and friend support and barriers) with vigorous exercise. Items that formed a "neighborhood environment" variable were included in their study (safety and ease of exercising in the neighborhood and frequently seeing others exercise). This variable did not emerge as a barrier to vigorous exercise. Neighborhood environment and convenience of facilities were not significantly associated with reported vigorous exercise (see Table 1). The strongest association with vigorous exercise in adjusted analysis was having home exercise equipment. A second study using the same items and participants²⁵ showed a weak association of "neighborhood environment" with walking for exercise. A subsequent prospective study with the same participants¹⁴ found neighborhood environment, convenience of facilities, and home equipment to be predictors of change in vigorous activity over 24 months in men only. In adjusted multivariate analysis, neighborhood environment was the only significant predictor (and negatively so) of change in vigorous activity for men.

Aspects of the physical environment such as "convenience of facilities" or "lack of facilities" are items that were frequently used in these self-report studies. For example, Sallis et al.²¹ found home equipment to be associated with doing strength-building exercises, and Booth et al.²² found accessibility of local facilities to be positively associated with older adults being categorized as sufficiently physically active in their leisure time for health benefits.

Sallis et al.²¹ used an explicitly identified ecologic model to develop 43 items to assess physical environment variables in college students. This study assessed

the behavior settings of homes and neighborhoods, as well as the convenience of 18 physical activity facilities (whether they were on a frequently traveled route). Presence of home equipment was associated with strength-building and vigorous exercise, and convenient facilities were associated with strength-building exercise. In adjusted multivariate analysis, only home equipment was significantly associated with strength-building exercise.

Booth et al.²² attempted to identify social cognitive and perceived environmental influences associated with physical activity in older adults. They used constructs from social cognitive theory, the theory of planned behavior, and ecologic models to inform the measurement aspects of their study. In a multivariate analysis, reported access to a park and perceiving footpaths as safe for walking were significantly associated with being categorized as sufficiently physically active for health benefits.

Sallis et al.²¹ also examined perceptions of the qualitative aspects (aesthetics) of neighborhoods. They found that a neighborhood environment scale, which comprised three separate components (neighborhood features, perceived safety, and neighborhood character), was not related to any measure of physical activity. They hypothesized that the lack of association may have been because if the neighborhood is not perceived safe, convenient, and enjoyable for physical activity, then people may be active in other environments, away from the local neighborhood. Another explanation could be that the composite outcome measure used in this study may have obscured associations that would be evidenced if items were examined individually.

Ball et al.²³ used a social-ecologic framework in examining relationships of seven environmental variables with reported walking for exercise. Items were grouped as perceptions of the "aesthetic nature of the environment" (three items), the "convenience of the environment" (three items), and social environment for walking (one item). Walking for exercise data were dichotomized into "any" or "no" reported walking in last 2 weeks. Those reporting a less aesthetically pleasing and less convenient environment were less likely to report walking.

King et al.¹⁸ examined the same neighborhood variables as Sallis et al.²¹ as well as a number of specific barriers in a sample of women aged >40 years. The outcome variable was dichotomous—active or sedentary. The two environmental barriers identified (lack of a safe place to exercise and poor weather) were not related to being active. The neighborhood characteristics of hills, enjoyable scenery, and unattended dogs were found to be significantly associated with physical activity.

A study by Sternfeld et al.¹⁵ on the physical activity patterns of ethnically diverse women aged 20 to 65 years examined occupational, sports and exercise, ac-

Table 1. Characteristics and main findings of studies examining relationships between perceived environmental attributes and physical activity among adults

Reference	Number/ age/ gender	Environmental variable	Scale	Setting	Physical activity behavior (main outcome variable)	Statistical adjustment	Significant associations with main outcome variable
Ball et al. (2001) ²³	N=3392 Adult M=46%	Your neighborhood is friendly You find it pleasant near your home Your local area is attractive A park or beach is within walking distance A cycle path is accessible Shops are in walking distance.	Likert (1–5)	Community open space	Walking for exercise (walking/ not walking)	A, S, E	Less aesthetic and less convenient environment associated with not walking
Booth et al. (2000) ²²	N=2374 ≥60 years M+F	Have you any exercise equipment at home (e.g., exercise bike, swimming pool, exercise video)? How safe do you feel walking during the day? Footpaths perceived as safe for walking. Accesses to facilities that may be used for activity (e.g., recreation enter, cycle path, golf course, gym, park).	Yes/no	Home community	Vigorous activities Walking for exercise, leisure, or recreation Moderate activities (active/inactive)	A, S	Footpaths safe for walking and access to local facilities associated with being active
CDC (1999) ²⁷	N=12,767 ≥18 years M+F	How safe from crime is your neighborhood?	Likert (1–4)	Not identified	Walking/moderate activity Vigorous activity (active/ inactive)	E, R	Unsafe neighborhood associated with being inactive
Hovell et al. (1989) ²⁵	N=2053 Adults M+F	Home equipment Number of facilities perceived as convenient Neighborhood environment	Rated frequency	Not identified	Walking for exercise	A, S, E	Neighborhood environment weak association with walking
Jakicic et al. (1997) ²⁶	N=194 27–45 yrs M+F	What types of sport, recreational, and exercise equipment do you have at home (14 types)?	Present/not present		Walking/stairs Sport and recreation activity (heavy/moderate/light/ blocks/flights/total)	A, NI	Total equipment association with heavy, moderate, and total activity
King et al. (2000) ¹⁸	N=2912 >40 years F only	Sidewalks Heavy traffic Hills Streetslights Unattended dogs Enjoyable scenery High levels of crime How safe is it to walk or jog alone during the day? Lack a safe place to exercise Poor weather	Present/not present	Leisure time, household, occupation	Moderate activity Vigorous activity (active/sedentary)	A, E, MS, L	Hills, unattended dogs, enjoyable scenery associated with being active

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Table 1. (continued)

Reference	Number/ age/ gender	Environmental variable	Scale	Setting	Physical activity behavior (main outcome variable)	Statistical adjustment	Significant associations with main outcome variable
Leslie et al. (1999) ²⁴	N=2729 15-76 years M+F M=42%	Awareness of campus facilities Gym membership	Yes/no	University campus	Walking for recreation and transport Moderate exercise Vigorous exercise (sufficient/insufficient)	A	More awareness associated with being sufficiently active
MacDougall et al. (1997) ²⁰	N=1765 Adults M+F	Recreation facilities Living environment	Likert (1-4)	Open space, sport facilities	Moderate activity Vigorous sport Walking for exercise (moderate active/inactive)	A, E, H	Low rating of facilities and environment associated with inactivity for men only
Sallis et al. (1989) ¹⁹	N=1789 Adults M+F	Lack of equipment Lack of facilities Lack of good weather Home equipment Neighborhood environment Number of facilities perceived as convenient	Rated frequency	Not identified	Vigorous exercise	A, S, E	Home equipment associated with vigorous exercise
Sallis et al. (1992) ¹⁴ (prospective study)	N=1719 18-90 years M+F	Same items as Hovell et al. (1989) ²⁵ and Sallis et al. (1989) ¹⁹	Rated frequency	Not identified	Vigorous exercise (change in vigorous activity)	A, E	Neighborhood environment associated with change in vigorous activity (men)
Sallis et al. (1997) ²¹	N=110 Mean = 20.6 years M=25%	Please indicate which items are in your home: 15 items (e.g., aerobic equipment, bicycle, dog, trampoline) Which apply to neighborhood? Sidewalks, heavy traffic, hills, streetslights, dogs unattended, enjoyable scenery, crime Rate your neighborhood as residential, commercial, or mixed How safe do you feel walking during the day? For each of 18 places you can exercise, indicate if it is on a frequently traveled route (e.g., aerobic studio, basketball court, beach)	Yes/no Yes/no Likert (1-5) Yes/no	Home community	Walking for exercise Strength exercise Vigorous exercise	A, S, R, SES	Home equipment associated with strength building exercise

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Table 1. (continued)

Reference	Number/ age/ gender	Environmental variable	Scale	Setting	Physical activity behavior (main outcome variable)	Statistical adjustment	Significant associations with main outcome variable
Shaw et al. (1991) ¹⁶	N=14,674 18-69 years M+F	No facilities nearby Available facilities are inadequate	Present/ absent	Not identified	Vigorous sport Moderate recreation Walking for exercise Cycling for exercise (participation/no participation)	None reported	No facilities associated with more participation (women only). Inadequate facilities associated with more participation
Stahl et al. (2001) ²⁸	N=3342 ≥18 years M=43%	My area offers many opportunities to be active Local clubs and other providers offer many opportunities	Likert (1-5)	Not identified	Total activity (active/inactive)	A, S, E	More awareness of opportunities for activity associated with more activity
Sternfeld et al. (1999) ¹⁵	N=5000 20-65 years F only	Lack of equipment Lack of facilities	Likert (1-5)	Occupational, home Leisure time	Occupational activity Household activity Sport and exercise Active living	A, E, R, C	Lack of equipment and facilities negatively associated with sport and exercise
Troped et al. (2001) ²⁹	N=413 Mean=51 years M+F M=40%	Which of the following apply to your neighborhood: sidewalks, heavy traffic, hills, enjoyable scenery? Rate your neighborhood as residential, mostly commercial, or mixed.	Yes/no	Community open space, neighborhood	(use/nonuse of bikeway)	A, S	Greater reported distance associated with less use. No busy street to cross associated with more use. Residential neighborhood (unadjusted analysis) associated with nonuse
Wilcox et al. (2000) ¹⁷	N=2912 ≥40 years F only	How safe do you feel walking during the day? Perceived distance from bikeway Negotiate a steep hill on the way to the bikeway Cross a busy street to access the bikeway Sidewalks Heavy traffic Hills Streetslights Unattended dogs Enjoyable scenery High levels of crime Easy access to walking trails, swimming pool Lack a safe place to exercise Poor weather	Likert (1-5) 1/4 mile Yes/no Yes/no Present/ absent	Leisure time Household Occupational	Moderate activity Vigorous activity (active/ sedentary)	A, S, E, R, L	Lack of scenery associated with being sedentary in rural women

A, age; C, children; CDC, Centers for Disease Control and Prevention; E, education; F, female; H, health status; L, location; M, male; MS, marital status; NI, number of individuals at home; R, race; S, sex; SES, socioeconomic status.

ive living (recreational), and household/caregiving physical activities. They found that the correlates of physical activity vary by the domain under which the behavior occurs. The environmental items (lack of equipment and facilities) were significantly related only to sport and exercise activity.

Studies Using Objectively Assessed Environmental Measures

Table 2 summarizes the methods and findings of studies that examined objectively assessed environmental factors. The physical activity behavior measured, the outcome variable, and the behavior setting are presented if reported.

Sallis et al.³¹ objectively plotted the addresses of respondents and all pay-for-use and free exercise facilities in local areas onto a grid map in order to assess the density of facilities near each participant. They found significant associations between the density of neighborhood, pay-for-use exercise facilities, and frequency of exercise, but no relationship with free facilities. In the case of free facilities, these may be aspects of communities (e.g., open grass-covered areas adjacent to schools) of which many people may not be aware, may not be aware that they could use, or may not believe that it would be appropriate to use.

Postal code areas were used by Bauman et al.³⁰ to objectively identify place of residence of Australian adults. A respondent was categorized as a "coastal" resident if their postal code touched the coastline; those in all other postal code areas were categorized as "inland" residents. Adult respondents who lived at a coastal postal code area were 23% less likely to be inactive and 38% more likely to report vigorous exercise.

Troped et al.²⁹ used geographic information systems (GIS) data to create three objective environmental variables (Table 2). The shortest-distance route from homes to an access point for a bikeway was inspected to determine if it intersected a busy street and whether this route crossed a steep slope grid. They compared these variables with self-reported perceptions of the same variables and found them to be correlated. Both self-report and GIS distance from the bikeway were associated with non-use of the bikeway. Self-report of having a busy street to cross and the GIS-measured steep-hills barrier was associated with bikeway non-use.

The physical environment was also assessed using geographically derived data by Giles-Corti and Donovan.³² Spatial access (distance by road) to recreational facilities (both natural and built) was not found to be associated with activity. The authors also measured functional environment (whether the participant's street had footpaths and visible shops) and the appeal of the environment (volume of traffic and number of trees). These two variables were not associated with

activity. However, unlike most of the other studies reviewed, a composite measure of all four variables demonstrated that a supportive physical environment had a significant association with the likelihood of being active.

Pattern of Findings

The findings of the studies reviewed in Tables 1 and 2 may be categorized within five sets of logical groupings: accessibility of facilities, opportunities for activity, weather, safety, and aesthetics. Safety, while not of itself an actual physical environment attribute, is plausibly related to factors in the physical environment (e.g., street lighting or the presence of sidewalks) that would affect perceptions of safety.

Findings of studies relating to accessibility of facilities, opportunities for physical activity, and the direction of these associations are summarized in Table 3. Findings pertaining to weather, items about safety while being active, and items regarding the aesthetic nature of the physical environment and the direction of these associations are summarized in Table 4.

Overall, the majority of variables pertaining to accessibility of facilities have been found to be associated with physical activity. Specific opportunities for activity also exhibited significant associations. A relationship between home equipment and physical activity was found for most of the studies that assessed this variable.^{19,21,25,26} Many of the items used in the studies were worded quite similarly (e.g., "lack of facilities" and "no facility nearby"). It may be that the number of items presented in Table 3 could have been narrowed down. However, a consideration in doing so is the personal interpretation that each individual respondent may have applied to similar items. Some items are very specific; for example, "a park or beach is in walking distance," whereas "awareness of facilities" is more general and each respondent would be more likely to apply his or her idiosyncratic interpretation to what was being asked.

Few studies examined the relationship between the weather and physical activity (Table 4). Poor weather was examined as a barrier to physical activity in two studies, but neither found a significant association.

Few of the studies that used items pertaining to "safety" reported significant associations with physical activity. "Footpaths perceived as safe for walking" was related to being active,²² and "unattended dogs" was also related to being active,¹⁸ presumably because those who were more active were more likely to be aware of dogs. A study of determinants on physical activity in rural and urban women aged >40 years¹⁷ did not find significant results for any safety items in relation to physical activity. These investigators used neighborhood environment items developed by Sallis et al.²¹ in their study. They found that rural women were less

Table 2. Characteristics and main findings of cross-sectional studies using objectively assessed environmental attributes of physical activity among adults

Reference	Number/ age/gender	Environmental variable	Scale	Setting	Physical activity behavior (main outcome variable)	Statistical adjustment	Significant associations with main outcome variable
Bauman et al. (1999) ³⁰	N=16,177 Adults M=42%	Place of residence	Inland/coastal	Not identified	Walking Moderate activity Vigorous activity (sedentary/ adequate/high)	A, S, E, Em, B	Coastal residence associated with adequate high, and negatively with sedentary
Giles-Corti and Donovan (in press) ³²	N=1803 18–59 years M+F	Functional (footpath/shop) Appeal (traffic/trees) Access to built facilities ^a Access to natural facilities ^a	Present/absent Distance Distance	Community open space Neighborhood Built facilities	Walking Moderate activity Vigorous activity (exercising 30 minute most days)	A, S, C, I, Em	No association of the four variables individually with exercising. Composite score associated with exercising 30 minute most days
Sallis et al. (1990) ³¹	N=2053 Mean=48 years M+F M=58%	Density of pay and free facilities	On grid-map	Not identified	Vigorous activity (sedentary/ exerciser)	A, E, I	Greater density of pay facilities associated with exerciser
Troped et al. (2001) ²⁹	N=413 Mean=51 years M+F M=40%	Distance to bikeway ^a Steep hill to bikeway ^a Cross busy street to bikeway ^a	GIS derived	Community open space Neighborhood	(use/non-use of bikeway)	A, S	GIS steep hill barrier and greater distance associated with non- use of bikeway

^aEnvironmental attribute variables derived from GIS databases.

A, age; B, country of birth; C, children; E, education; Em, employed; F, female; GIS, geographic information system; I, income; M, male; S, sex.

Table 3. Patterns of findings on associations of accessibility of facilities and opportunities for activity, with physical activity

Environmental variable	Studies (citation #)	Associations
Accessibility of facilities		
A cycle path is accessible	23	+
Busy street to cross	29	—
Busy street to cross ^a	29	0
Negotiate steep hill	29	0
Negotiate steep hill ^a	29	—
Access to facilities (local park)	22	+
Facilities on frequently traveled route	21	+
Density of pay and free facilities ^a	31	+
Neighborhood residential	29	—
Number of convenient facilities	19,25	0 / 0
Lack of facilities	15,19	— / —
No facility nearby (women)	16	—
Available facilities inadequate	16	—
Access to built facilities ^a	32	0
Access to natural facilities ^a	32	0
Distance to bikeway	29	—
Distance to bikeway ^a	29	—
Park or beach in walking distance	23	+
Shops are in walking distance	23	+
Opportunities for activity		
Presence of sidewalks	17,21	0 / 0
Home equipment	19,21,22, 25,26	+ / + / 0 / 0 / +
Lack of equipment	15,19	— / —
Awareness of facilities	24	+
Satisfaction with recreation facilities	20	+
Neighborhood environment	19,25	0 / +
My area offers opportunities for physical activity	28	+
Local clubs and others provide opportunities	28	+
Coastal residence	30	+
Functional environment (footpath/shop)	32	0

+, significant positive association found with physical activity; —, significant negative association found with physical activity; 0, no association found with physical activity.

^aObjectively assessed by geographic information system or other objective data.

likely to report sidewalks, streetlights, high crime rates, and lack of a safe place to exercise, compared to urban women. Using data from selected states in the 1996 Behavior Risk Factor Surveillance System, the Centers for Disease Control and Prevention²⁷ in the United States found that people who perceived their neighborhood to be unsafe were more likely to be physically inactive. Significant associations emerged for aesthetics items, particularly those pertaining to the attractiveness and pleasantness of the local environment having enjoyable scenery and a friendly neighborhood.

Table 4. Patterns of findings on the associations of weather, safety, and aesthetic factors, with physical activity

Environmental variable	Studies (citation #)	Associations
Weather		
Poor weather	18	0
Lack of good weather	19	0
Safety		
Footpaths are safe	22	+
How safe to walk or jog alone in day	18,21,22	0 / 0 / 0
Lack a safe place to exercise	17,18	0 / 0
High levels of crime	17,18	0 / 0
Unattended dogs	17,18	0 / +
Streetlights	17,18	0 / 0
How safe from crime is your neighborhood	27	+
Heavy traffic	17,18	0 / 0
Aesthetics		
Neighborhood friendly	23	+
Pleasant near home	23	+
Local area is attractive	23	+
Enjoyable scenery	17,18	+ / +
Hills	17,18	0 / +
Living environment	20	+
Appeal (traffic/trees)	32	0

+, significant positive association found with physical activity; 0, no association found with physical activity.

Discussion

The associations of environmental attributes with physical activity have thus far been examined in a relatively limited set of studies. This review has examined the evidence for these relationships and highlighted relevant aspects of the measures that have been used in these studies. There were inherent difficulties, as some studies combined several physical environment items into an “overall” measure and compared that total score to physical activity behavior. Where it was possible to identify and separate the environmental items, we did so. By including only studies that examined relationship to physical activity behavior, we adhered to a quite strict criterion so that descriptive studies reporting (e.g., frequency of barrier items in a population) were not included.

In this field, many of the empirical studies have been only recently reported and the relevant theory is not yet well developed. The environmental attributes measured in the different studies are based in part on pragmatic insights and operationalized some broad theoretically derived constructs. The outcome variables used in the studies are also derived from different physical activity measures. A systematic review, providing a description of what the various studies have found and providing some preliminary classification of findings, should thus be helpful.

The labels we used in Tables 3 and 4 are not proposed as definitive constructs. These labels portray

"groupings" of environmental variables that we believe have some face validity. They potentially can be used as a descriptive jumping-off point for future research and would, we hope, be the basis for a more theoretical synthesis as the research literature in this field develops. Future research studies and theory development will undoubtedly produce a more refined and theoretically anchored set of constructs for characterizing environmental influences on different physical activity behaviors.

"Environmental influences" are currently identified within social cognitive and ecologic models of health-related behavior. However, the environmental component of these theories and models, while identified as important, has thus far been only broadly articulated.^{4,6,9} We are not proposing here what could be seen as a "premature synthesis" of findings. Currently, even the most relevant theory does not provide sufficiently detailed conceptual tools for differentiating how the separate domains of environmental influences might impact on different physical activity behaviors.

Aspects of home environments were found to be associated with physical activity in cases where respondents reported having, for example, exercise videos and equipment. Aspects of the neighborhood environment were found to be associated with physical activity. The availability of, and access to, cycleways, footpaths, health clubs, and swimming pools were found to be associated with physical activity.^{16,21,22,28,29} Evidence appears to be accumulating for the importance of accessibility of facilities as an important environmental factor related to physical activity.

The development of objective measures of environmental factors is an important new direction for research. The use of GIS data to create physical environment variables on roads, hills, and street addresses and other variables^{29,32} is showing some initial support for findings from self-report measures. Including GIS data in studies has considerable promise. GIS-derived measures can help to overcome some of the methodologic problems of reliance on self-reported environmental factors.³³ Although the influence of the physical environment on activity behavior was found to be weak by Giles-Corti and Donovan,³² they found that accessibility to facilities was associated with their use. They concluded that a supportive environment would seem to be necessary, but may be insufficient on its own, to increase activity levels of populations.³²

Public health strategy to promote physical activity is now strongly emphasizing the role of environmental influences to create opportunities and remove barriers to people being more active in their daily lives.^{1,5} The studies that we have reviewed are part of an expanding corpus of new research, seeking evidence that physical activity can be influenced by environmental attributes. While the importance of such influences would seem to be self-evident, the assertive pursuit of advocacy for

physical activity opportunities must be strengthened by relevant empirical evidence. With one exception,¹⁴ the studies that we have reviewed present only cross-sectional associations of environmental attributes with physical activity behavior. Prospective and intervention studies are particularly needed so that conclusions can be drawn regarding the possible causal nature of these environment-behavior relationships.

Although "weather" items were found not to be strongly related to physical activity, it was difficult to assess their contributions because in most studies they were pooled with items related to other constructs. Studies need to incorporate the reported weather variable as a separate item. There may be some utility to wording that is more explicit about context (e.g., "it's too cold/hot to go walking"). Seasonal variation is not a fixed attribute of the environment, but a number of features—daylight hours, temperature, humidity, precipitation, and wind—may influence physical activity. We chose not to include studies of seasonal variation in our review. Two studies^{34,35} have reported that most activity was found to occur in the summer months and that this could vary by the particular activity and the individual.

The "aesthetics" or "neighborhood character" variables show promise, with significant associations emerging in the four studies that included them. Further studies are needed, perhaps including more variations on this dimension and examining it in relation to different types of activity (e.g., walking and sport participation). It is likely that there will be different environmental influences on different types of activity.⁶

Findings for "safety" items, somewhat surprisingly, demonstrated few associations with physical activity. A possible explanation for the lack of association with safety is that for people who are physically active in places other than their neighborhood, neighborhood safety may not be an issue. Perhaps safety would seem to be applicable only to outdoor activity and needs to be applied in studies that only measure specific outdoor activities, not total activity. At first glance, unattended dogs being positively related to activity seems counter-intuitive. On further consideration, perhaps it is only those people who are active and thus out in the street who know about the unattended dogs. A significant association was found between perceived safety from crime and physical activity behavior by the Centers for Disease Control and Prevention.²⁷ Safety may also need to be separated into further categories. These could include perceived safety from crime or safety from injury (e.g., lack of footpaths). Future research should explore possible gender differences in perceived safety for exercising.

When a number of physical environment variables are combined (e.g., in a "total neighborhood" measure), possible associations can potentially be obscured. In one study,²¹ the variables included safety and char-

acter of the local neighborhood in a single scale and did not find a significant association with physical activity.

Twelve of the studies reviewed operationalized one or more theoretically derived constructs. Most were based on social cognitive theory or ecologic models. A common factor in these models is that they incorporate explicit environmental constructs. Overall, there would seem to be some evidence that studies based on theoretical underpinnings that are inclusive of environmental influence on physical activity would be advantageous. The origin of the physical environment scales and factors measured are sometimes not explicitly explained in the studies. Some report that the items were based on a particular theory, without any description of how they were developed. Others state that the items were based on qualitative studies or on measures reported in previous studies.

A number of the significant findings explored relationships to vigorous activity, with relatively fewer findings on moderate-intensity activities or walking. These differences contributed to the difficulty of reviewing this literature. Diverse behaviors and environments were studied, and the studies themselves used various ways of measuring these associations. Behavior-specific items need to be developed that address—and assess—attributes specific to a particular behavior in a particular context or setting.⁴ Prospective studies of environmental factors as predictors of physical activity change are needed (we identified only one such study¹⁴), as are environmentally focused intervention studies.³⁶ If particular environmental attributes identified in cross-sectional studies are to be advocated in order to influence policy changes and large-scale environmental innovations, evidence from intervention studies is crucial.^{3,37} In light of the available evidence, we would conclude that research on environmental influences has considerable promise for the purpose of identifying significant and potentially modifiable influences on physical activity behavior.

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APPENDIX A-2

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Running head: Associations of environmental attributes

Associations of Location and Perceived Environmental Attributes
with Walking in Neighborhoods

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Abstract

Purpose Ecological models of health behavior highlight the importance of environmental influences on participation in physical activity. We examined associations of coastal versus non-coastal place of residence and perceived attributes of the physical environment with neighborhood walking, total walking and total activity.

Design Cross-sectional survey administered by telephone.

Setting Workplace setting in a small regional city.

Participants Staff at an Australian University (n= 800).

Measures Perceptions of environmental attributes, postcode of residence, physical activity.

Results Men were significantly more likely to be in the highest category of neighborhood walking if they lived in a coastal location (odds ratio [OR] =1.66), and highly rated environmental 'aesthetics' (OR =1.91), 'convenience' of facilities (OR =2.20) and 'access' to facilities (OR =1.98). Women were significantly more likely to be in the highest neighborhood walking category if they had high ratings of 'convenience' (OR =3.78), but were significantly less likely if they had high ratings for 'access' (OR =0.48). For total walking and total physical activity, few significant associations emerged.

Conclusions Neighborhood environmental attributes were related to walking in the neighborhood but not to more general activity indices. Limitations are nature of the sample and that the perceived environment questions did not elicit detailed environmental characteristics. Understanding gender-specific environmental correlates of physical activity should be a research priority.

KEY WORDS: walking, physical activity, environment, perceptions

PURPOSE

Given the modest and short-term impacts of individually focused informational and behavior-change interventions¹, physical activity promotion efforts are beginning to incorporate environmental change strategies. Public health recommendations emphasize regular moderate-intensity activity² and walking is the most common physical activity¹. Consistent with ecological models^{3,4}, environmental influences are expected to be setting-specific. Thus, neighborhood environment attributes ought to be more-strongly related to walking in the neighborhood than to more general indices of activity.

We examined associations of an objective physical environment variable, coastal versus non-coastal geographical location⁵ and perceived attributes of the neighborhood environment with the specific behavior of walking in the neighborhood setting. Relationships between perceived attributes of the neighborhood environment and more-inclusive measures of total walking (including neighborhood walking) and total physical activity were also examined. Because levels and types of physical activity differ significantly by gender² and gender-specific correlates of physical activity are poorly understood⁶, gender-specific analyses were conducted.

METHOD

Design

The study was a cross-sectional survey conducted by telephone to examine associations of location and perceived environmental attributes with physical activity.

Sample

The population for the study was staff members at a university in a small regional Australian city. The eligible sample included 1409 potential respondents, from which complete interviews were obtained from 800 (57%). Of those who were called, 294 (21%) refused to participate, and 315 (22%) could not be contacted during the survey period. The final sample of 800 included 398 (49.8%) women and 402 (50.3%) men. Ages ranged from 18 to 71 years with a mean age of 43 years. Full-time workers made up 83% of the sample. Academic (faculty) staff members were 53%, and general staff were 43% of the total sample (4% did not identify their job classification).

Measures

The telephone survey comprised of items pertaining to physical activity, location of participants' residence by postal code and perceptions of the neighborhood environment.

Physical activity behavior. Physical activity was assessed using the short form of the International Physical Activity Questionnaire (IPAQ). This instrument distinguishes vigorous-intensity, moderate-intensity and walking activity separately (three items) in terms of frequency (days/week) and duration (min/day) of each activity category in the past seven days. These activity categories may be treated separately or summed to gain an overall estimate of the total physical activity performed in a week (minutes/week). The IPAQ has been designed and evaluated for reliability and validity by the International Consensus Group on Physical Activity Measurement⁷, (see also IPAQ website, <http://www.ipaq.ki.se>).

Neighborhood walking. Consistent with the rationale for behavior-specific and context-specific measurement^{3,4} the physical activity behavior of neighborhood walking was separately assessed with one item. Participants were asked: “How many times a week do you go for a walk for any reason (e.g., for exercise, doing errands, walking for transport) in and around your neighborhood?” “How much time would you usually spend when you do go for a walk in and around your neighborhood?”. The frequency of walking was multiplied by the number of usual minutes, to give an index of reported minutes of neighborhood walking each week.

Location by postal code. A postal code district is generally equal to one suburb. Australian Bureau of Statistics 1996 Census data were used to identify postal code areas that abut the coastline. This was coded into non-coastal (30%) or coastal (70%) location.

Perceived environment attributes. Neighborhood environment attribute items were based on a review of studies on relationships between environment attributes and physical activity behaviors⁸. The eight items were preceded by the statement “The following questions will ask you to rate aspects of your home neighborhood that might influence whether or not you walk”. As the method of administering this survey was telephone interview, we used a 1-10 rating scale. The anchors for each item were matched to the wording of each item (for example, “on a scale of 1-10 where 1 is not at all friendly and 10 is very friendly”). There were two items that specifically assessed the generally-positive nature of the local physical and social environment [aesthetics]. These were “How would you rate the general friendliness of the people?”; “How enjoyable is the scenery?”. Three items specifically asked about the convenience of walking opportunities in the neighborhood [convenience]: “How would you rate the walking distance to park or beach?”; “How accessible is a path or cycleway for walking?”; and, “Overall, how convenient is it to walk in your neighborhood?”. Two items assessed access to services [access]: “How would you rate the walking distance to shops?”; “How would you rate the walking distance to a bus stop or train station”. One item asked, “How much of a problem is traffic when walking in your neighborhood?” [traffic].

Method of analysis. Items in the ‘aesthetics’, ‘convenience’ and ‘access’ categories were summed to provide a total score for each category of environmental attribute. Summed scores of ‘aesthetics’, ‘convenience’, ‘access’ to services and ‘traffic’ were transformed into categorical variables based on tertiles; low (a less positive perception of the environment), moderate, and high (a highly positive perception of the environment).

Logistic regression models were used to examine the association of ‘location’ and the perceived environmental attributes, with the three outcome variables: neighborhood walking; total walking (the IPAQ walking item which incorporates neighborhood walking); and, total physical activity (sum of IPAQ walking, moderate-intensity activity and vigorous activity items, with vigorous activities given a weighting of two). All models controlled for age and education. Each outcome variable was dichotomized at the median. All five physical environment attribute variables, plus age and education, were entered simultaneously into the separate models for men and women.

RESULTS

Men living in a coastal location were 1.66 times more likely to be in the high neighborhood walking group (Table 1). Among men, there were positive associations of the 'aesthetics' and 'convenience' and 'access' perceived-environment attribute categories with neighborhood walking. Those with a moderate 'aesthetics' score were 1.77 times more likely, and those with the highest scores of 'aesthetics' were 1.91 times more likely to report a higher level of neighborhood walking. Those with the highest scores on 'convenient' environment were 2.20 times more likely to be in the highest neighborhood walking participation group. A high 'access' score was associated with men being 1.98 times more likely to be in the highest walking group. Interestingly, a significant negative relationship emerged with men for 'traffic'. Those in the highest level (traffic is not a problem) were 55% less likely ($OR = 0.45$) to be in the highest neighborhood walking group.

For women, those with a moderate 'convenience' score were 3.19 times, and those with a high score were 3.78 times more likely to have a higher level of neighborhood walking. A significant negative association for 'access' to services with neighborhood walking emerged for women. A high score for the 'access' environment attribute resulted in women being 52% less likely to be in the high neighborhood walking category ($OR = 0.48$). The objective 'location' variable did not evidence any association among women.

Only two significant associations were observed among men and one among women for perceived environment attributes with total walking and total physical activity (see Table 1).

DISCUSSION

Summary

Neighborhood walking (but not total walking and total physical activity) had strong relationships with objectively determined place of residence and with perceived physical environment attributes, consistent with predictions from ecological models of health^{3,4}. Different aspects of the physical environment may influence different activity behaviors, and environmental factors are expected to have their strongest effects on behavior in those same environments. By focusing investigation on a particular behavior in a particular setting, a clearer picture emerges of the environment-physical activity connection.

Gender-specific associations were notable. For men, having the highest 'access' scores (less perceived distance to shops, bus stop/train station) meant they were *more* likely to be in the highest group for neighborhood walking. However, women who perceived the distance as very close were *less* likely to be in the high category of neighborhood walking. Even if shops are perceived as close, this may not necessarily influence women's choice to walk to them. The necessity of carrying shopping bags home may also be an influence. Because other studies have found environmental correlates of physical activity in the unexpected direction⁹, correlates with specific environmental variables need to continue to be explored.

Table 1

Logistic Regression Model Stratified by Gender: Odds Ratios and 95%CI for Location and each Category of Environmental Variables and the Likelihood of being in the Higher Category of Participation for Neighborhood Walking, Total Walking and Total Physical Activity.

	Men			Women		
	Neighborhood walking	Total walking	Total physical activity	Neighborhood walking	Total walking	Total physical activity
Location						
Non-coast	1.00	1.00	1.00	1.00	1.00	1.00
Coast	1.66 (1.04-2.67)*	1.01 (0.64-1.59)	1.12 (0.70-1.76)	0.99 (0.62-1.58)	1.00 (0.63-1.58)	0.99 (0.63-1.57)
Aesthetics						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.77 (1.06-2.97)*	1.29 (0.77-2.14)	1.10 (0.66-1.84)	1.40 (0.79-2.46)	1.15 (0.66-2.01)	0.78 (0.45-1.36)
High	1.91 (1.08-3.37)*	1.69 (0.97-2.94)	1.56 (0.89-2.73)	1.30 (0.71-2.36)	1.44 (0.79-2.60)	1.25 (0.69-2.24)
Convenience						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.34 (0.80-2.24)	1.09 (0.65-1.80)	0.97 (0.58-1.61)	3.19 (1.81-5.59)***	1.51 (0.87-2.60)	1.24 (0.72-2.12)
High	2.20 (1.21-3.99)**	1.37 (0.77-2.43)	1.82 (1.02-3.24)*	3.78 (2.12-6.73)***	1.37 (0.79-2.38)	1.12 (0.65-1.93)
Access						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	1.63 (0.97-2.74)	1.57 (0.94-2.63)	0.87 (0.52-1.46)	0.62 (0.34-1.10)	1.92 (1.10-3.37)*	1.25 (0.71-2.17)
High	1.98 (1.12-3.49)*	2.09 (1.20-3.64)**	1.55 (0.89-2.69)	0.48 (0.27-0.87)*	1.12 (0.63-1.98)	1.24 (0.70-2.19)
Traffic						
Low	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.94 (0.56-1.56)	0.68 (0.41-1.12)	0.77 (0.47-1.28)	0.81 (0.48-1.36)	0.95 (0.57-1.58)	0.79 (0.47-1.31)
High	0.45 (0.25-0.81)**	0.79 (0.46-1.37)	0.77 (0.44-1.33)	0.95 (0.54-1.65)	1.04 (0.60-1.79)	0.90 (0.52-1.55)

* p<.05 ** p<.01 *** p<.001

A strength of our study was the testing of associations while adjusting for the other environmental variables as well as important demographic variables. Significant relationships emerged for all five environmental attribute variables with men in a multivariate analysis in which the other environmental attributes were controlled. For men, three of the five environmental variables had odds ratios near 2.0. This suggests a population-wide association with environment features that is substantial. Although correlates for women were less consistent, those with high ‘convenience’ scores were almost four times as likely to be high neighborhood walkers.

Limitations

The cross-sectional design limits the conclusions that can be drawn. The generalisability of our results is also limited due to the nature of the study sample. The sample was university staff, with 71% having a university level of education. Another limitation was related to the structure of the perceived environmental questions that did not elicit specific or detailed environmental characteristics, and we did not measure walking for specific purposes such as errands or commuting. Such measures should be used in future research. Further studies are needed on the measurement properties perceived-environment scales. Although it was interesting to replicate the association of coastal residence with physical activity⁵ the reasons for the association were not apparent. The majority of the participants resided in a coastal location, the geographical nature of the district being a long narrow strip between mountains and the coastline, so our findings may be subject to selection bias.

Implications

The strong associations found for all of the environment attribute variables with neighborhood walking demonstrates the importance of the physical environment when considering strategies to increase physical activity². Convenience of recreational facilities was related to neighborhood walking, so these data strengthen current recommendations to provide such facilities in all neighborhoods¹⁰. These findings also support conceptual models that posit the physical environment as a strong influence on physical activity and other behaviors^{3,4}. Because current findings varied by gender, we encourage other investigators to conduct gender-specific analyses of environment-behavior associations. There is the need to strengthen the theoretical underpinnings of such models and to obtain further evidence from studies of a broader range of communities and from prospective investigations.

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APPENDIX A-3

Humpel, N., Marshall, A., Leslie, E., Bauman, A., & Owen, N. (in press). Changes in neighborhood walking are related to changes in perceptions of environmental attributes. *Annals of Behavioral Medicine*.

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Changes in Neighborhood Walking are Related to Changes in Perceptions of
Environmental Attributes

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ABSTRACT

Several studies have found significant cross-sectional associations of perceived environmental attributes with physical activity behavior. Prospective relationships with environmental factors have been examined for vigorous activity, but not for the moderate-intensity activities now targeted in public health campaigns and through environmental and policy initiatives. We examined, prospectively, changes in perceptions of environmental factors and changes in neighborhood walking. Baseline and 10 week follow-up data were collected from 512 participants via telephone interview. Positive changes in perceptions of environmental attributes were associated with increases in walking. Men reporting a positive change in 'aesthetics' and 'convenience' were twice as likely to increase their walking, but those reporting 'traffic' to have become less of a problem, were 61% less likely to report an increase in walking. Women reporting more positive perceptions of 'convenience' were more than twice as likely to have increased their walking, and those reporting 'traffic' to have become less of a problem were 76% more likely to have increased their walking. Further studies are needed to determine the possibly causal nature of such environment-behavior relations. Such evidence will help to build the conceptual and empirical underpinnings of public-health initiatives to increase participation in physical activity.

INTRODUCTION

The health benefits of regular physical activity are well established (1). Being more active is related to reduced risk of several chronic diseases (2-4). The current public-health position on physical activity is that the greatest gains for population health will accrue if sedentary adults are encouraged participate in regular moderate-intensity activity (1, 4-6). Walking is the most commonly reported form of moderate-intensity activity in Australia (4) and in the USA (7). Walking is a practically and financially accessible physical activity option for most segments of the community, and unlike more vigorous activities, shows little decline in middle age (8).

Public health strategies to increase participation in physical activity now focus explicitly on supportive factors in the physical environment (9-11). Ecological models of physical activity behavior identify multiple levels of influence from interpersonal, intrapersonal, social and broader environmental domains (10, 12-14). Such models focus particular attention on the physical environment. Environmental contexts for physical activity may have a positive or negative impact, depending upon the influence of a number of attributes (14). Given the broad nature of ecological models, specific explanatory models for particular activity behaviors are needed (10, 15). For example, environmental influences on walking may be different to those for vigorous activity or for other moderate-intensity activities and may not be well explained by more generic models of physical activity and exercise behavior (13, 14).

In examining the influence of environmental factors, it is important to examine objectively-observable domains such as distance to facilities (16, 17) and the location of participant's homes (18). For example, an Australian study found that coastal place of residence was associated with adults being more likely to be physically active after controlling for the effects of socio-demographic variables (18). But it is also important to understand the influence of perceptions of particular attributes such as the aesthetic nature of the environment, or whether suitable places for activity are believed to be accessible or conveniently located (19, 20). Several studies have found significant positive relationships between perceived physical environment attributes and physical activity (9). However, most studies have used generic physical activity indices or have examined associations only with vigorous-intensity activities (9). A small number of studies have reported evidence that neighborhood environment factors are associated with the specific behavior of walking (9, 20-23). However, there is as yet no strong theoretical basis for identifying relevant environmental dimensions (9, 10, 14). Based on our earlier review and categorization of studies examining perceived-environment factors associated with physical activity (9) and on findings from an earlier Australian study of the correlates of walking (20), we identified the dimensions of 'aesthetics', 'convenience', 'access' to services and 'traffic' as most relevant to the purposes of our study.

Because the majority of reported findings come from cross-sectional studies, they do not provide evidence of a causal role for environmental factors in influencing physical activity behavior. One study did examine the influence of environmental factors prospectively, but the associations were with vigorous-intensity activities only (24). Evidence from prospective studies is required that relates to more moderate-intensity activities like walking, as these make major contributions to total health-related physical activity levels of populations. Prospective studies specifically focused

on walking and its proximal environmental context, although they do not provide unequivocal evidence of causality, can elucidate temporal relationships between environmental attributes and physical activity behavior. Such evidence can be stronger than that provided by cross-sectional studies, for understanding how changes to the physical environment, or to public perceptions of the environment, might be targeted in community-wide interventions.

While it is becoming more accepted that the physical environment may influence physical activity, the development of measures of environment-behavior relationships is still at a relatively early stage. In particular, measures of perceptions of the environment with acceptable psychometric properties are lacking. Therefore we examined the test-retest reliability of items used to evaluate perceived environmental attributes and also the item developed to measure the specific behavior of neighborhood walking.

The main aim of this study was to examine associations of changes in adults' perceptions of environmental attributes with changes in their walking behavior. It was predicted that those who became more positive in their perceptions of their neighborhood environment would be more likely to increase their level of neighborhood walking. We also expected that those participants with the most positive perceptions of the neighborhood environment at baseline would be less likely to report an increase in walking, as previous studies had shown them to be more likely to be already active (9, 19, 20). Because factors influencing physical activity have often been found to be gender-specific (1, 24) but few studies thus far have explored the influence of the physical environment in this way, we examined the relationship between environmental perceptions and walking behavior separately for men and women.

METHODS

Study context

This study was carried out within the context of a physical activity intervention trial designed to test the efficacy of a website delivered self-help physical activity program in a workplace setting. The intervention was not designed to influence perceptions of the environment. Institutional ethics approval was obtained prior to the study.

Participants

The study sample was selected from the academic and general staff of a medium-sized Australian university. There were 1409 potential respondents identified, from whom baseline data were collected from 800 (57%) by telephone interview. Of these, 655 agreed to be followed-up. Follow-up data were collected 10 weeks later from 512 participants.

The mean age of the group was 44 years ($SD = 9.9$) with a range from 18 to 69 years. 49% were men, with a mean age of 46 ($SD = 9.9$) years; and, 51% were women with a mean age of 43 (9.7) years. The sample was composed of 47.5% academic and 52.5% general staff. Those who took part in both the baseline and follow-up survey were not different to the original sample on demographic profiles or overall physical activity levels.

Measures

Both the baseline and 10 week follow-up survey included the same items to assess perceived environmental attributes and walking behavior.

Neighborhood walking. Consistent with the case for behavior-specific and context-specific measurement (9,12-14), the behavior of neighborhood walking was assessed. Participants were asked: “How many times a week do you go for a walk for any reason (e.g., for exercise, doing errands, walking for transport) in and around your neighborhood?” “How much time would you usually spend when you do go for a walk in and around your neighborhood?” (in minutes). The frequency of walking was multiplied by the number of minutes for each time, to provide a total number of minutes of neighborhood walking each week.

Perceived environment attributes. Neighborhood environment attribute items were based on findings from a review of studies that assessed relationships between environment attributes and physical activity behaviors (9). The eight items were preceded by the statement “The following questions will ask you to rate aspects of your home neighborhood that might influence whether or not you walk”. Each item was rated on a ten point scale, with ‘1’ being ‘not at all favorable’, and ‘10’ being ‘very favorable’.

There were two items that specifically assessed the generally-positive nature of the local physical and social environment [aesthetics]. These were “How would you rate the general friendliness of the people?”; “How enjoyable is the scenery?”. Three items specifically asked about the convenience of walking opportunities in the neighborhood [convenience]. These were “How would you rate the walking distance to park or beach?”; “How accessible is a path or cycle way for walking?”; “Overall, how convenient is it to walk in your neighborhood?”. Two items assessed access to services [access], that is, “How would you rate the walking distance to shops?”; “How would you rate the walking distance to a bus stop or train station”. One item asked, “How much of a problem is traffic when walking in your neighborhood?” [traffic]. Items in these categories were summed to provide a total score for each category of environmental attribute. For some analyses, these summed scores were transformed into categorical variables with three levels; low (a less positive perception of the environment), moderate, and high (a highly positive perception of the environment). Scores that most closely approximated the tertiles of the relevant data distributions defined the three levels. To facilitate comparison of environmental perception categories in Table 2, each summed category score was divided by the number of items contained in that category, to give a score ranging from 0 to 10.

The items selected for inclusion in this study are supported by an earlier Australian study (20) that found significant associations between categories of ‘aesthetics’ and ‘convenience’ and walking. That study reported a confirmatory model which showed that all items loaded satisfactorily on these two constructs (explaining 36-64% and 10-60% of the variance respectively).

Relative change in perceptions of the environment. In order to control for the effect of baseline levels of perceptions of the environment (which has been found in previous studies to be significantly associated with being more active; 9), a relative change variable (proportional change scores) was constructed for each of the four

categories of perceived environment. This was computed by subtracting the follow-up scores from the baseline scores and then dividing by the baseline score, to give a proportional index of change relative to baseline perceptions. For each environmental category, scores were dichotomized at zero, with no change or a decrease in score as one level, and any increase in score as the other level. These relative change scores were used in all logistic regression analyses.

Location by postal code. Previous Australian studies (18, 25) have found that in locations where participants' postal code abuts the coastline, physical activity tends to be higher, after adjustment for educational level and other socio-demographic factors. Therefore, participants in this study were identified as coastal or non-coastal residents from their postcode of residence based on a structured query language function using the Australian Bureau of Statistics 1996 Census data.

Dose of intervention. Whilst the intervention was not designed to influence perceptions of the environment, to control for any potential effects, data pertaining to receipt and use of the intervention were included as a co-variate in the analyses. A variable related to the dose of intervention recalled by the participants was created, which was then split at the median, to create an index of 'high' and 'low' dose of intervention. This variable was then used in the logistic regression analyses.

Test-retest reliability of the items used to evaluate perceived environmental attributes and the neighborhood walking question was conducted with a sample of 80 adults (35 men and 45 women with a mean age of 43 years ($SD = 11$)). Participants were contacted by telephone and responded to the same questions twice over a period of two to three days (mean 2.44 days ($SD = 0.78$)). For both interviews participants were asked about the preceding seven days.

Data analyses

A series of logistic regression models was used to examine the associations of 'location' and the relative change in perceived environmental categories with three outcome variables: any increase in neighborhood walking; an increase of 30 minutes or more; and, an increase of 60 minutes or more. Given the range of measurement error associated with self-report of physical activity (26), we chose to examine stringent criteria for change (minimum increases of 30 minutes and 60 minutes of walking in addition to any increase in walking). Several past studies have found that the factors influencing physical activity differ for men and women (1, 27). For this reason, we stratified the logistic regression models by gender. The four perceived physical environment attribute variables (aesthetics, convenience, access and traffic), plus age, education, intervention 'dose' and objectively-assessed location of residence (coastal versus non-coastal) were entered simultaneously into separate models for men and for women.

RESULTS

Test-retest reliability

Table 1 presents the intraclass correlation (ICC) and 95% confidence interval (95%CI) results for each perceived environmental category for the total sample and separately for men and women. For 'aesthetics', 'convenience' and 'access' to services excellent agreement was found for both men and women. 'Traffic' as a problem, showed the lowest reliability at 0.66 (0.60-0.82) for the total sample,

however this is still a very good result. The specific neighborhood walking item was found to have excellent agreement between testings. The ICC and 95%CI's for the total sample were 0.92 (0.88-0.95). Spearman's correlation coefficients were also run for all items, producing similar results.

TABLE 1

Intra-class Correlations and 95% Confidence Intervals for Environmental Perception Categories and Neighborhood Walking

	Total sample	Men	Women
Environment categories			
Perceived Aesthetics	0.93 (0.90-0.96)	0.90 (0.81-0.95)	0.95 (0.91-0.97)
Perceived Convenience	0.86 (0.79-0.91)	0.81 (0.65-0.90)	0.89 (0.80-0.94)
Perceived Access to services	0.86 (0.79-0.91)	0.84 (0.70-0.91)	0.87 (0.77-0.93)
Perceived Traffic as a problem	0.73 (0.60-0.82)	0.66 (0.43-0.81)	0.77 (0.62-0.87)
Walking			
Neighborhood walking	0.92 (0.88-0.95)	0.82 (0.67-0.91)	0.95 (0.90-0.97)

Prospective study

For men, there was a non-significant decrease in mean minutes of walking from baseline to follow-up. Women reported a non-significant increase in mean minutes of walking (see Table 2). Forty percent of men, and 40.8% of women reported an increase of 30 minutes or more neighborhood walking. Of these, 33.3% of men and 33.1% of women reported an increase in walking of more than 60 minutes. Women reported slightly more positive perceptions of the environment than did men, although few of the differences were statistically significant (see Table 2; a low score is a less positive perception for that environmental category; a high score is a more positive perception for that environmental category. Specifically, women's perception of the 'aesthetics' and 'access' to services environmental attributes were significantly higher than those reported by men (Table 2). However, by the follow-up no significant differences were apparent between the genders. The percentages of participants who increased scores on perceptions of the neighborhood environment can be found in Table 2.

TABLE 2

Baseline and Follow-up Neighborhood Walking (minutes/week) and Perceptions Scores for Environmental Attributes for Men and Women.

	Men				Women			
	Baseline		Follow-up		Baseline		Follow-up	
	M	SD	M	SD	%	M	SD	%
Minutes of walking								
Overall	111	157	107	197		107	112	118
Non-coastal residents	94	122	121	115		96	106	104
Coastal residents	119	170	100	111		112	115	124
								147
Environment categories								
Perceived aesthetics	7.56	1.64	7.98**	1.61	54.3	8.05*	1.59	7.99
Perceived convenience	7.16	2.20	7.48	2.05	50.4	7.20	2.25	7.56
Perceived access to services	6.64	2.30	7.07**	2.29	53.4	7.16*	2.36	7.15
Perceived traffic	7.58	2.41	7.93	2.40	45.6	7.71	2.48	7.98
								2.07
								43.5

* significantly different mean scores between genders

** significantly different mean scores from baseline to follow-up
% percentage of participants who reported improved perceptions

Participants who reported the least positive perceptions of the environment at baseline were found to have the greatest increase in perceptions scores at follow-up, for all four perceived environment categories. Those with a low score for ‘aesthetics’ at baseline reported a mean *relative change* increase of 0.42 (SD = 0.46), whereas those with a high initial score for ‘aesthetics’ reported a decrease, with a *relative change* score of - 0.16 (SD = 0.18). For ‘convenience’, those with low baseline score reported a mean *relative change* increase of 0.79 (0.87) and those with high baseline score reported a *relative change* decrease of - 0.21 (0.22). For ‘access’, the increase in *relative change* score for those with initial low scores was 0.35 (2.14), and a decrease score of - 0.24 (0.24) was reported for those with an initial high score. For ‘traffic’ as a problem, those with a low baseline score reported a *relative change* increase of 1.13 (1.83) whereas those with high initial score reported a decrease of - 0.20 (0.22).

Participants with high (more positive) self-reported perceptions for the categories ‘aesthetics’, ‘convenience’ and ‘access’ at baseline, did not significantly alter their walking behavior. However, those participants with high scores for ‘traffic’ at baseline (traffic not a problem) did report an increase in walking.

There were non-significant increases in environmental perceptions for those reporting a ‘high’ dose of the intervention with no evidence of a relationship between ‘dose’ and change in walking at follow-up. ‘Dose’ was not a significant predictor in any of the logistic regression models.

Logistic regression models examined whether an increase in perceptions of the neighborhood environment over time was associated with the three specific walking outcomes. For men, all three outcome variables exhibited strong associations with one or more of the environmental categories (see Table 3). Men who increased their perception of ‘aesthetics’ were 2.25 times more likely to have increased walking and twice as likely to have increased walking more than 30 minutes compared to men who did not favorably change their perceptions of ‘aesthetics’. The same trend was evident for increased walking of 60 minutes or more, but was not statistically significant. The pattern of results was similar for perceptions of ‘convenience’. Men reporting an improved perception of ‘convenience’ had almost twice the likelihood of increasing their walking across all three outcome categories. An increase in perceived ‘access’ to services, however, did not show the same trend. Men who perceived ‘traffic’ as being less of a problem were found to be *less* likely to have increased their participation in walking across all three outcome variables. Men who were coastal residents were less likely to have increased their walking, but this result was only significant for an increase in walking of 60 minutes or more.

TABLE 3

Odds ratios (95%CI) for Changes in Perceptions of Neighborhood Environmental Attributes and Their Association with an Increase in Walking Behavior Among Men and Women

	MEN			WOMEN		
	Any increase in walking	Increase of 30 minutes or more	Increase of 60 minutes or more	Any increase in walking	Increase of 30 minutes or more	Increase of 60 minutes or more
Change in perception of aesthetics						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	2.25** (1.24-4.05)	2.06* (1.12-3.79)	1.82 (0.97-3.38)	1.74 (0.99-3.06)	1.30 (0.73-2.30)	1.09 (0.60-1.97)
Change in perception of convenience						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.95* (1.10-3.45)	2.02* (1.12-3.65)	1.98* (1.08-3.61)	2.58*** (1.46-4.56)	2.31** (1.29-4.14)	2.01* (1.09-3.70)
Change in perception of access						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	1.17 (0.66-2.05)	1.11 (.062-1.99)	0.99 (0.54-1.80)	0.78 (0.45-4.56)	1.01 (0.58-1.77)	1.00 (0.56-1.78)
Change in perception of traffic						
Decrease/ no change	1.00	1.00	1.00	1.00	1.00	1.00
Increase	0.40** (0.22-0.72)	0.29*** (0.15-0.54)	0.39** (0.21-0.73)	1.58 (0.91-2.72)	1.76* (1.01-3.05)	1.41 (0.79-2.48)
Location						
Non-coastal	1.00	1.00	1.00	1.00	1.00	1.00
Coastal	0.68 (0.37-1.22)	0.63 (0.34-1.15)	0.49* (0.27-0.91)	1.35 (0.75-2.43)	0.90 (0.50-1.63)	1.06 (0.57-1.96)

*p<.05 **p<.01 ***p<.001

For women, an increase in perceived 'convenience' showed the strongest association with an increase in walking (Table 3). Women whose perceptions about 'convenience' became more positive were twice as likely to report an increase in their walking levels (across all three categories) compared to those with who did not positively change perceptions of 'convenience'. Increases in perception that 'traffic' was not a problem was significantly associated with women being 1.76 times more likely to have an increase in walking of 30 minutes or more. There was no association between coastal versus non-coastal location and increased walking for women.

Logistic regression models also tested for possible interactions amongst the perceived environmental attributes on neighborhood walking. Only one significant interaction term emerged. Among men, this was between relative change in 'access' to services and relative change in 'traffic' ($p < .009$), indicating that the influences on walking of 'traffic' and 'access' are not independent of each other.

DISCUSSION

This is the first study to prospectively examine the relationship between perceptions of the environment and changes in walking behavior. As we have previously argued, drawing on ecological models (10, 12-14), there is the need for prospective studies and for studies examining relationships of environmental factors to particular physical activity behaviors. This study found that self-reported perceptions of neighborhood environmental attributes did change over time. Those who initially had the least positive perceptions demonstrated the greatest increase, and those with initially more-positive perceptions remained stable or showed some decrease in scores. This might be explained in terms of regression to the mean. However, this finding is consistent with what would be expected from the outcomes of earlier studies (9), which reported that those who were already active (and thus less likely to become more so) had the most positive perceptions of environmental attributes.

The changes in perceptions of environmental attributes occurred over a relatively short time period (ten weeks), and it is not known whether the changes would be maintained or fluctuate over a longer period. If the changes in perceptions of 'aesthetics' and 'convenience' were maintained over the longer term, and were associated with sustained increases in walking, then these factors may be more likely to be acting as causal influences. It is, however, possible that those who became more active began to more-accurately perceive their environment, thus leading to the relationships that we have reported. Our findings do not demonstrate causal relationships, but they do add to the body of evidence (9) that there are systematic relationships between people's perceptions of their environments and their physical activity behaviors. To conclude that such relationships are causal will require a larger body of evidence, particularly from studies that experimentally manipulate environmental-perception variables and from 'natural experiments' in which people are exposed, prospectively, to environmental changes.

To examine associations of changes in environmental perceptions with changes in the specific behavior of walking we used three outcomes (any increase, 30 minutes or more, 60 minutes or more) in order to test the associations across

increasingly exacting criteria. This is because small increases in self-reported walking, while significant, could nevertheless be within the range of measurement error for self-reported physical activity (26). Generally, we found similar strengths of association for any increases in walking and for increases of 60 minutes or more.

Our results indicate excellent test-retest reliability for the perceived environmental attribute categories. This provides early confidence in the reproducibility of the measures of these 'constructs' of environmental influence on walking behavior. The measure of neighborhood walking also exhibited excellent reliability. Most participants were able to recall the frequency and duration of time spent walking in the neighborhood with good accuracy. This indicates that any change observed over time could be interpreted as real changes in both environmental perceptions and behavior. A weakness in our study is that we did not also examine the validity of the measure of walking.

The differences in the findings for the men and for the women further emphasize the need to carry out gender-specific analyses in physical activity studies (24). An increase in positive perceptions of the environment was found to be more strongly associated with increased walking for men than for women. For the change in perceptions of 'aesthetics', men were twice as likely to increase their walking more than 30 minutes, but for women, this association was non-significant. An increase in perceived 'convenience' proved to be a strong predictor of walking for both men and women. The data for both men and women showed no significant associations of changes in perceived 'access' to services with an increase in walking across any of the outcome categories. Changes to how close or far participants perceived the distance to shopping venues and other facilities to be were not related to any increases in walking.

Changes in the perception of 'traffic' as a problem and its association with increased walking are of interest. The direction of the association was positive for women, but was negative for men. Men who perceived traffic to be less of a problem were less likely to increase their walking in or around their neighborhood. This is counter-intuitive, but is consistent with the findings of an earlier study of the cross-sectional associations of perceived environmental factors with neighborhood walking (25), where high scores on 'traffic' were associated with a decreased likelihood of neighborhood walking for men. There was an interaction between 'access' to services and 'traffic' as a problem for men, indicating that the influences of men's perceptions of 'traffic' and 'access' on their walking are not independent of each other. It may be that for men, perceptions of 'access' to services like shops or a bus stop differs as a function of their perceptions of 'traffic' as a problem. The other possibility is that the effect of 'traffic' is dependent on men's level of perception of 'access'.

The women in this study were found to be more likely to increase their walking participation if their perceptions of 'traffic' improved. Further research is required to examine this specific environmental factor, perhaps using more items to assess this variable, as only one item was used in this study. Having a pleasant, attractive environment for walking may be important for men, but the amount of traffic in the neighborhood may be less of a concern.

Men living in a coastal location were only half as likely to increase their time spent walking by 60 minutes or more. One possible explanation for this is that men living in a coastal location are already more active, leaving less room for improvement. In a previous study (25), it was shown that men who lived on or near the coastline were 1.66 times more likely to be in the higher level of neighborhood walking participation compared to men who lived in a non-coastal location; whereas for women, no effect of location was found. The lack of location effect found for women may be a consequence of women who choose to walk in their neighborhood being more likely to do so for functional, rather than for aesthetic reasons (25).

The data used in this study were collected from participants who were part of an intervention trial, and although the intervention was not designed to influence their perceptions of their neighborhood environment it cannot be ruled out as a possibility. Self-instructional physical activity interventions, similar to that used in the trial that provided the context for the present study, often identify specific settings and opportunities for activity in their program materials (28). Such strategies may act to sensitize participants to contextual factors. We attempted to control for the effect of the intervention by entering 'dose' of intervention into the logistic regression models. There was no relationship observed with neighborhood walking. Another possible limitation of this study is the use of University staff as the sample, although it should be noted that 52.5% of the sample were general, rather than academic staff. Higher educational attainment is a consistent correlate of higher levels of activity among Australian adults (29). All data were collected via self-report telephone interview and as such these data may be subject to biasing influences, compared to data collected from objective measures (10, 16, 17).

The finding of relationships in unexpected directions between walking and perceptions of 'traffic' that differed for men and women in this study, and findings from other studies that show such differences for other environmental variables (9, 35) highlights the need to further explore specific environmental factors related to physical activity. The associations found in our study were in relation to the specific behavior of walking; it would be useful for future studies to also further test the applicability to other activities such as bicycling or other active recreation or transport options. Additional prospective studies are needed to confirm our findings, to test their generalisability and to also examine the sources of the gender differences that we have identified.

In summary, this study adds to the growing body of evidence on the links between physical environment attributes and physical activity behavior. Our findings suggest that perceptions of environments for walking may not be fixed attributes and thus may be amenable to change. Environment-behavior relationships differed for women compared to men. Such differences need to be further examined.

While research on environmental-behavior relationships for physical activity is still at an early stage of development (9), it has some potentially important public health implications. Influencing the precursors of behavioral change (awareness, knowledge, attitudes and intentions) is a fundamental goal of health campaigns (30, 31). Physical activity mass-media campaigns have tended to focus on influencing awareness and knowledge of health benefits and attitudes to physical activity itself (32, 33). Future physical activity campaigns might focus more explicitly on

influencing perceptions of environmental contexts for activity. This will become increasingly relevant, as environmental and policy changes (34) lead to more opportunities for physical activity and to community settings being more amenable to people being active (eg, more walking paths, cycleways, attractive landscaping). In this context, it could be relevant to target awareness, knowledge and attitudes related to environmental settings for physical activity (12-14); this would be in contrast to targeting the behavior itself. Doing so could involve the reinforcement of positive perceptions of attributes of the environmental contexts for walking ('aesthetics' and 'convenience' in particular), and also changing negative perceptions. By focusing on a quite specific behavior (walking, in contrast to being generally more active), and on specific aspects of the environmental context of that behavior, it may be possible to target some unique precursors of behavioral change in large groups of people.

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APPENDIX B:

Surveys associated with this thesis

APPENDIX B-1

Reliability study survey

APPENDIX B-1

Telephone protocol and reliability study survey

Telephone Interview script

"Good morning/afternoon. May I please speak to "inserts respondent's name"

[IF NO] Is there a time that I can call back to speak to _____[respondent's name]_____.

If NO ask ' is there a more convenient time I could call back?'

Record time here_____

WHEN RESPONDENT IS SPEAKING

This is Nancy Humpel calling from the Faculty of Health and Behavioural Sciences. You were involved in a physical activity project conducted here at the University last year. As part of that project you said you wouldn't mind being contacted again at a future date. I am the PhD student who was involved in the project and I'm now doing a small project to check how reliable the measures were that we used in the study. I would really appreciate if you could spare about 5 minutes at the most of your time. Your answers will remain confidential and you may refuse to answer any questions you wish to.

I'll need to talk to you just once more after this, to have you answer the questions again two days later. That would be all I would be asking you to do again.

Can we go ahead with the survey now?

If YES proceed to the survey

If NO ask ' when is a more convenient time to call back?'

Record time here_____ day_____

Name _____

Ph _____

Gender M

F

The following questions ask about how you would rate aspects of your home neighbourhood that might influence whether or not you walk.

Please give each aspect a rating on a scale from 1 to 10. 1 or 2 would be a low rating, 9 or 10 would be a high rating

1. How would you rate the friendliness of your neighbourhood
(1 being very unfriendly, 10 being very friendly)
1 2 3 4 5 6 7 8 9 10
2. How enjoyable is the scenery for walking
(1 being not very enjoyable, 10 being very enjoyable)
1 2 3 4 5 6 7 8 9 10
3. How would you rate the walking distance to shops in your neighbourhood
(1 being too far away, 10 being very close)
1 2 3 4 5 6 7 8 9 10
4. How would you rate the walking distance to a park or beach
(1 being too far away, 10 being very close)
1 2 3 4 5 6 7 8 9 10
5. How would you rate the walking distance to a bus stop or train station
(1 being too far away, 10 being very close)
1 2 3 4 5 6 7 8 9 10
6. How much of a problem is traffic when walking in your neighbourhood
(1 being a very big problem, 10 being no problem at all)
1 2 3 4 5 6 7 8 9 10
7. Overall, how convenient is it to walk in your neighbourhood
(1 being very inconvenient, 10 being very convenient)
1 2 3 4 5 6 7 8 9 10
8. How accessible is a path or cycleway for walking
(1 being not at all accessible, 10 being very accessible)
1 2 3 4 5 6 7 8 9 10

We are interested in the physical activities that people do as part of their everyday lives.

9. How many times a week do you go for a walk for any reason in and around your neighbourhood?

_____ times /week

9.A. How long would you usually spend walking when you do go for a walk around your neighbourhood?

_____ hrs _____ mins

I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Now, think about all the vigorous activities which take hard physical effort that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think about *only* those physical activities that you did for at least 10 minutes at a time.

10a During the last 7 days, on how many days did you do vigorous physical activities?

_____ days per week

< Refused

< Don't know

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

10b How much time in total did you usually spend on one of those days doing **vigorous** physical activities?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: "What is the total amount of time you spent over the last 7 days doing vigorous physical activities?"

_____ hours _____ minutes per week]

Now think about other activities, which take moderate physical effort that you did *in the last 7 days*.

Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking. Again, think about *only* those physical activities that you did for at least 10 minutes at a time.

11a During the last 7 days, on how many days did you do **moderate** physical activities?

_____ days per week

< Refused

< Don't know

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

11b How much time in total did you usually spend on one of those days doing **moderate** physical activities?

_____ hours _____ minutes

[Interviewer clarification: Think about only those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: What is the total amount of time you spent over the last 7 days doing moderate physical activities?

_____ hours ____ minutes per week]

Now think about the time that you spent walking in the last 7 days.

This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure (including any neighbourhood walking).

12a During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

- < Refused
- < Don't know

[Interviewer clarification: Think about only the walking that you do for at least 10 minutes at a time.]

12b How much time in total did you usually spend walking on one of those days?

_____ hours ____ minutes

[Interviewer probe: An average time per day is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: What is the total amount of time you spent walking over the last 7 days?

_____ hours ____ minutes per week]

13. To what extent do you see walking for errands or for transport as an opportunity to be more active, or as an inconvenience? Answer on a scale from 0-10, where 0 means a very definite inconvenience and 10 means a very definite opportunity.

0 1 2 3 4 5 6 7 8 9 10

What is your age_____

Thank you, this completes the survey,

When would be a suitable time to call back in two days?

_____time _____date

Again, thank you for your time. Goodbye.

APPENDIX B-2

Workplace study baseline survey

The questions that pertain the study of Part 3 are highlighted in the survey

Active Living Online Baseline Survey

1 Variable (CPHONE)

"Good morning/afternoon. May I please speak to [INSERT RESPONDENT'S NAME]. [IF NO] Is there a time that I can call back to speak to [RESPONDENTS NAME]. [IF NO AGAIN - PERSIST: EXPLAIN WHO YOU ARE AND WHY YOU ARE CALLING] ...so is there a time when I can call back to speak to him/her?

[IF REFUSAL] Thank you for your time. Goodbye.

[WHEN RESPONDENT IS SPEAKING]

Hello, my name is ..., I am calling from IRIS Research on behalf of the Faculty of Health and Behavioural Sciences at the University of Wollongong. We are conducting a research study to find better ways to help busy adults to be more active. You should of received an email outlining the details of this survey about two weeks ago. Before I continue [INSERT RESPONDENTS NAME] would I be able to confirm your details ...[CLICK INTERVIEW AND READ OUT EMAIL AND DEPARTMENT ADDRESS].

2 Variable (PAR1)

Do you recall receiving an e-mail letter last week about a staff survey being conducted as part of a study being funded by the National Heart Foundation?

1 Yes

2 No

[Jump to 5]

3 Variable (PAR2)

Since you did receive the e-mail, I'm calling you to complete the survey. All your answers will be treated as confidential and this data will not be kept with your name.

If there are any questions you prefer not to answer you can just tell me to move to the next question. Is it alright to go on with the survey now?

1 Yes

2 No

[Jump to 11]

4 Variable

Is there a better time for me to call you back?

[IF YES SUSPEND INTERVIEW, IF NO TERMINATE]

[IF THEY WISH TO PROCEED WITH THE INTERVIEW GO BACK TO PAGE 3]

[ONLY READ OUT FOR CALL BACKS]

Hello, my name is ... I am calling from IRIS Research on behalf of the Faculty of Health and Behavioural Sciences at the University of Wollongong.

I understand that you were previously contacted and that this was a more convenient time for you to do this survey. Is it alright to go on with the survey now?

[IF YES GO BACK TO PAGE 3]

[IF NOT A CONVENIENT TIME SUSPEND INTERVIEW]

[IF DONT WANT TO DO SURVEY AT ALL TERMINATE]

5 Variable (PAR4)

I am sorry that you did not receive it. Could I tell you what was in the e-mail now, so that you can decide whether you would like to help us with this survey?

1 Yes

2 No

[Jump to 9]

6 Variable (READ OUT EMAIL)

7 Variable

Now we would like to ask you a set of questions, which should take less than ten minutes. All the answers you give to us will be completely confidential, and of course you may refuse to answer any questions you do not want to. We appreciate your time and would like to encourage you to participate, but of course you are under no obligation and you may withdraw your consent at any time. Your decision to proceed with this survey will in no way affect anything to do with your employment at the University of Wollongong.

8 Variable (PAR5)

Is it alright to go on with the survey now?

1 Yes

2 No

[Jump to 11]

9 Variable (Q9A)

Would you like me to send you another e-mail?

1 Yes

2 No

[Jump to 61]

10 Variable

Ok, that email will be sent out to you and I'll give you a call back in a few days. Thank you for your time.

[SUSPEND INTERVIEW]

Hello, my name is ... I am calling from IRIS Research on behalf of the Faculty of Health and behavioural Sciences at the University of Wollongong.

You would of received a call a few days ago about participating in a staff survey being conducted as part of a study being funded by the National Heart Foundation. I'm calling you to complete the survey. All your answers will be treated as confidential and this data will not be kept with your name. Is it alright to go on with the survey now? [IF NOT CONVENIENT TIME SUSPEND, IF NOT INTERESTED TERMINATE]

11 Variable

We are interested in the physical activities that people do as part of their everyday lives. I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work; as part of your house and yard work; to get from place to place, and in your spare time for recreation, exercise or sport.

Now, think about all the vigorous activities which take **HARD PHYSICAL** effort that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast cycling. Think about only those physical activities that you did for at least 10 minutes at a time.

12 Variable (Q1A)

During the last 7 days, on how many days did you do vigorous physical activities for at least 10 minutes at a time? [INCLUDE ALL JOBS]

- 1 none [Jump to 14]
- 2 one day
- 3 two days
- 4 three days
- 5 four days
- 6 five days
- 7 six days
- 8 seven days
- 9 DONT KNOW [Jump to 14]
- 10 REFUSED TO SAY [Jump to 14]

13 Variable (Q1B)

How much time in total did you usually spend on one of those days doing vigorous physical activities for at least 10 minutes at a time?

[ANSWER IN HOURS AND MINUTES]
[IF PATTERN OF TIME SPENT DOING PHYSICAL ACTIVITIES
VARIES WIDELY FROM DAY TO DAY, ASK]

What is the average time spent per day on physical activities?

Hours

Minutes

14 Variable

Now think about other activities which take **MODERATE PHYSICAL** effort that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, cycling at a regular pace, or doubles tennis. Do not include walking. Again, think about only those physical activities that you did for at least 10 minutes at a time.

15 Variable (Q2A)

During the last 7 days, on how many days did you do moderate physical activities for at least 10 minutes?

- 1 none

2 one day

3 two days

4 three days

5 four days

6 five days

7 six days

8 seven days

9 DONT KNOW

10 REFUSED TO SAY
- [Jump to 17]

[Jump to 17]

[Jump to 17]

16 Variable (Q2B)

How much time in total did you usually spend on one of those days doing moderate physical activities for at least 10 minutes at a time?

[IF PATTERN OF TIME SPENT DOING PHYSICAL ACTIVITIES VARIES WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day on moderate physical activities?
Hours

Minutes

17 Variable

Now think about the time you spent WALKING in the last 7 days. This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

18 Variable (Q3A)

During the last 7 days, on how many days did you walk for at least 10 minutes at a time? [PROMPT IF REQUIRED] Think about only the walking that you do for at least 10 minutes at a time. Include all jobs.

- 1 none

2 one day

3 two days

4 three days

5 four days

6 five days

7 six days

8 seven days

9 DONT KNOW

10 REFUSED TO SAY
- [Jump to 20]

[Jump to 20]

[Jump to 20]

19 Variable (Q3B)

How much time in total did you usually spend walking on one of those days?

[IF PATTERN OF TIME SPENT WALKING VARIES WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day on walking?

Hours

Minutes

20 Variable

Now, think about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time.

This may include time spent sitting at a desk, visiting friends, reading, traveling on a bus or sitting or lying down to watch television.

21 Variable (Q4A)

During the last 7 days, how much time in total did you usually spend sitting on a week day? [PER DAY TOTAL]

[PROMPT IF REQUIRED] Include time spent lying down (awake) as well as sitting]

[IF PATTERN OF TIME SPENT LYING DOWN VARIES

WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day lying down?
[ANSWER IN HOURS AND MINUTES]

Hours

Minutes

22 Variable (Q4B)

During the last 7 days, how much time in total did you usually spend sitting on a week-end day?
[PER DAY TOTAL]

[IF PATTERN OF TIME SPENT LYING DOWN VARIES

WIDELY FROM, ASK] What is the average time spent on the weekend lying down? [ANSWER
IN HOURS AND MINUTES]

Hours

Minutes

23 Variable (SEX)

The next set of questions are important as they help classify your answers.

**From your voice I assume that you are ...[MALE, FEMALE. NEVER ASSUME, ALWAYS
CONFIRM]**

1 Male

2 Female

3 REFUSED

24 Variable (BIRTH)

How old were you on your last birthday?

25 Variable (MARITA)

What is your current marital status?

- 1 Married/defacto
- 2 Single
- 3 REFUSED TO SAY

26 Variable (EDUCA)

What is your highest level of education?

- 1 Never attended school/some primary
- 2 Primary school
- 3 Some high school
- 4 School certificate (4th form)
- 5 HSC/Leaving Certificate (6th Form)
- 6 TAFE Certificate/diploma
- 7 University CAE or other Tertiary degree
- 8 Other

27 Variable (WORK)

Do you currently work full or part time?

- 1 Full time
- 2 Part time
- 3 REFUSE TO ANSWER

28 Variable (HRSWOR)

On average, how many hours would you normally spend working each week?

29 Variable

Do you mind telling us what your job classification is at work?

- WORKA Academic Level A (Tutor/lecturer)
- WORKB Academic Level B (Lecturer)
- WORKC Academic Level C (Senior Lecturer)
- WORKD Academic Level D (Associate Professor)
- WORKE Academic Level E (Professor)
- WORKF General Level 1
- WORKG General Level 2
- WORKH General Level 3
- WORKI General Level 4
- WORKJ General Level 5

WORKK General Level 6
WORKL General Level 7
WORKM General Level 8
WORKN General Level 9
WORKO General Level 10

30 Variable (TRAVWO)

On the days that you come to work, how much time do you usually spend travelling TO work?
[GIVE ANSWER IN
HOURS AND MINUTES]
Hours

Minutes

31 Variable (WALKCY)

How much of THAT time is spent either walking or cycling? [ANSWER IN MINUTES]

32 Variable (HOMEW)

On the days that you come to work, how much time do you usually spend travelling HOME from work? [ANSWER IN
MINUTES]
Hours

Minutes

33 Variable (HOMEWC)

How much of THAT time is spent either walking or cycling? [ANSWER IN MINUTES]

34 Variable (WALKDA)

Do you ever walk for exercise or recreation DURING your BREAKS AT WORK? [CONFIRM FREQUENCY]

- 1 Yes everyday (5DAYS)
- 2 Yes on most days (3 or 4 DAYS)
- 3 Yes sometimes (1 or 2 DAYS)
- 4 Never

[Jump to 36]

35 Variable (WALBRE)

When you walk for exercise or recreation DURING your BREAKS AT WORK, how much time do you usually spend walking? [ANSWER IN MINUTES]

36 Variable (CHILDR)

Do you have any children living at home?

1 Yes

2 No

3 REFUSED TO SAY

37 Variable (KG)

What is your approximate weight in kilograms, or stones and pounds?

1 Kilograms

2 Stones and pounds

3 Refused to say

[Jump to 39]

[Jump to 40]

38 Variable (KG1)

KG [ENTER WEIGHT IN KILOGRAMS]

39 Variable (STONES)

[Skip If KG = 1]

Stones [ENTER WEIGHT IN STONES]

Pounds [ENTER WEIGHT IN POUNDS]

40 Variable (CM)

What is your approximate height in centimeters or feet and inches?

1 cm

2 Feet and inches

3 Refused to say

[Jump to 42]

[Jump to 43]

41 Variable (CM1)

cm [ENTER HEIGHT IN CM]

42 Variable (FEETIN)

[Skip If cm = 1]

Feet [ENTER HEIGHT IN FEET]

Inches [ENTER HEIGHT IN INCHES]

43 Variable (HEALTH)

How would you rate your general health status?

[READ FIRST 5 OPTIONS]

1 Excellent

2 Very Good

3 Good

- 4 Fair
- 5 Poor
- 6 DONT KNOW
- 7 REFUSED TO ANSWER

44 Variable

The next question is about your usual level of physical activity and your intention to be active in the future. Think about ALL the physical activity you do in a week.

Do you participate in moderate and or vigorous physical activity on MOST days of the week for around 30 minutes each time? [READ OPTIONS]

- Q14A Yes, and I have been for MORE than 6 months.
- Q14AB Yes, and I have been, but for LESS than 6 months
- Q14AC No, but I intend to in the next 30 days
- Q14AD No, but I intend to in the next 6 months
- Q14AE No, and I DO NOT intend to in the next 6 months

45 Variable (Q15)

The next question will ask you to select from five different options, please wait until I have told you all five options before answering. How active do you think you are compared to other people of the same age and gender?

- 1 Much more active
- 2 Little more active
- 3 About the same
- 4 A little less active
- 5 Much less active
- 6 CANT SAY

46 Variable (Q17A)

In the past week, have you had any health problems that may have significantly limited your ability to be physically active.

- 1 Yes
- 2 No [Jump to 48]
- 3 CANT SAY [Jump to 48]

47 Variable (Q17B)

Can you please tell me what it was?

48 Variable (Q18A)

Within the last month, have you seen any of the following types of information about physical activity.

[READ OUT]

Booklets (please specify if yes)

- 1 Yes [Q18AA (C 50)]

- 2 No
- 3 CANT SAY

49 Variable (Q18C)
Websites (please specify if yes)

- 1 Yes [Q18CC (C 50)]
- 2 No
- 3 CANT SAY

50 Variable (Q18F)
Have you seen any other types of information about physical acitivty during the last month?
Other (please specify if yes)

- 1 Yes [Q18FF (C 50)]
- 2 No
- 3 CANT SAY

51 Variable
The next few questions will ask you about any environmental factors related to walking in your neighbourhood.

52 Variable (POSTCO)
What is your postcode at home?

53 Variable (WALKXW)
How many times a week do you go for a walk for any reason in and around your neighbourhood? [TIMES PER WEEK]

54 Variable (WALKMI)
How long would you usually spend walking when you do go for a walk around your neighbourhood? [ANSWER IN MINUTES]

55 Variable
The following questions will ask about how you would rate aspects of your home neighbourhood that might influence whether or not you walk. Please give each aspect a rating on a scale of 1 to 10, where 1 or 2 would be a low rating and 9 or 10 would be a high rating.

56 Variable (Q21A)

How would you rate the friendliness of your neighbourhood? On a scale of 1 to 10, where 1 is very unfriendly and 10 is very friendly. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very Unfriendly
- 2 .
- 3 .
- 4 .
- 5 .
- 6 .
- 7 .
- 8 .
- 9 .
- 10 Very Friendly

57 Variable (Q21B)

How enjoyable is the scenery for walking? On a scale of 1 to 10, where 1 is not very enjoyable and 10 is very enjoyable. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Not very enjoyable
- 2 .
- 3 .
- 4 .
- 5 .
- 6 .
- 7 .
- 8 .
- 9 .
- 10 Very enjoyable

58 Variable (Q21C)

How would you rate the walking distance to shops in your neighbourhood? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very far away
- 2 .
- 3 .
- 4 .
- 5 .
- 6 .
- 7 .
- 8 .
- 9 .
- 10 Very close

59 Variable (Q21D)

How would you rate the walking distance to a park or beach? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very far away**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**
- 10 Very close**

60 Variable (Q21E)

How would you rate the walking distance to a bus stop or train station? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very far away**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**
- 10 Very close**

61 Variable (Q21F)

How much of a problem is traffic when walking in your neighbourhood? On a scale of 1 to 10, where 1 is a very a big problem and 10 is no problem at all. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very big problem**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**
- 10 No problem at all**

62 Variable (Q21G)

Overall, how convenient is it to walk in your neighbourhood? On a scale of 1 to 10, where 1 is very inconvenient and 10 is very convenient. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

1 Very inconvenient

2 .

3 .

4 .

5 .

6 .

7 .

8 .

9 .

10 Very convenient

63 Variable (Q21I)

How accessible is a path or cycleway for walking? On a scale of 1 to 10, where 1 is very inaccessible and 10 is very accessible. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

1 Very inaccessible

2 .

3 .

4 .

5 .

6 .

7 .

8 .

9 .

10 Very accessible

64 Variable (Q22A)

That completes the formal part of the survey, however, there is just one more question I would like to ask. Would you be willing to participate in a similar survey in the future and/or receive some resources about physical activity in the mail or via the internet?

1 Yes

2 No

65 Variable

That's all. Thank you very much for your time and co-operation.

APPENDIX B-3

Workplace study follow-up survey

The questions that pertain the study of Part 3 are highlighted in the survey

Active Living Online Follow-up Survey

1 Variable (CPHONE)

Good morning /afternoon. May I please speak to ...[INSERT NAME].

[IF NO] Is there a time that I can call back to speak to ...[INSERT NAME]

[IF STILL NO] It is very important that we speak with [INSERT NAME] as he/she has agreed to receiving this telephone call, so is there a time when I can call back to speak to him/her? [PUT IN CALL BACK] [IF STILL NO] OK I will try again later, thank you for your time.[PUT IN CALL BACK]

[WHEN RESPONDENT IS SPEAKING]

Hello, my name is ... from IRIS Research. I am calling on behalf of the Faculty of Health and Behavioural Sciences at the University. You may recall participating in a physical activity survey about 12 weeks ago. At that time you agreed to be part of a follow up survey. I am calling you now to conduct that follow up. All answers you give us will be completely confidential and of course you may refuse to answer any questions you do not want to. Is it alright if we go through the survey now? [IF NO] Is there a more convenient time for me to call you back? [PUT IN CALL BACK] [IF STILL NO] The survey should only take about 10 minutes, are you sure you would not like to help us with this survey? [IF STILL NO] Ok, thank you for your time, we will not call you again about this survey. [TERMINATE]

2 Variable

For our follow up survey, we need to ask you again about the physical activities you do as part of your everyday life. I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work; as part of your house and yard work; to get from place to place, and in your spare time for recreation, exercise or sport.

Now, think about all the vigorous activities which take **HARD PHYSICAL** effort that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, running, aerobics, or fast cycling. Think about only those physical activities that you did for **AT LEAST 10 MINUTES AT** a time.

3 Variable (Q1A)

During the last 7 days, on how many **DAYS** did you do vigorous physical activities for at least 10 minutes at a time? [INCLUDE ALL JOBS]

1 none

[Jump to 5]

2 one day

3 two days

4 three days

5 four days

6 five days

7 six days

8 seven days

9 DONT KNOW

[Jump to 5]

10 REFUSED TO SAY

[Jump to 5]

4 Variable (Q1B)

How much TIME IN TOTAL did you usually spend on one of those days doing vigorous physical activities for at least 10 minutes at a time?

[ANSWER IN HOURS AND MINUTES]
[IF PATTERN OF TIME SPENT DOING PHYSICAL ACTIVITIES VARIES WIDELY FROM DAY TO DAY, ASK]

What is the average time spent per day on physical activities?
Hours

Minutes

5 Variable

Now think about other activities which take MODERATE PHYSICAL effort that you did in the last 7 days. Moderate physical activities make you breathe somewhat harder than normal and may include carrying light loads, cycling at a regular pace, or doubles tennis. Do not include walking in this answer, we will ask you separately about this. Again, think about only those physical activities that you did for AT LEAST 10 MINUTES at a time.

6 Variable (Q2A)

During the last 7 days, on how many DAYS did you do moderate physical activities for at least 10 minutes?

- | | |
|-------------------|---------------|
| 1 none | [Jump to 8] |
| 2 one day | |
| 3 two days | |
| 4 three days | |
| 5 four days | |
| 6 five days | |
| 7 six days | |
| 8 seven days | |
| 9 DONT KNOW | [Jump to 8] |
| 10 REFUSED TO SAY | [Jump to 8] |

7 Variable (Q2B)

How much TIME IN TOTAL did you usually spend on one of those days doing moderate physical activities for at least 10 minutes at a time?

[IF PATTERN OF TIME SPENT DOING PHYSICAL ACTIVITIES VARIES WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day on moderate physical activities?

Hours

Minutes

8 Variable

Now think about the time you spent WALKING in the last 7 days. This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for recreation, sport, exercise or leisure.

9 Variable (Q3A)

During the last 7 days, on how many DAYS did you walk for at least 10 minutes at a time?
[PROMPT IF REQUIRED] Think about only the walking that you do for at least 10 minutes at a time. Include all jobs.

- 1 none

2 one day

3 two days

4 three days

5 four days

6 five days

7 six days

8 seven days

9 DONT KNOW

10 REFUSED TO SAY
- [Jump to 11]

[Jump to 11]

[Jump to 11]

10 Variable (Q3B)

How much TIME IN TOTAL did you usually spend walking on one of those days?
[IF PATTERN OF TIME SPENT WALKING VARIES WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day on walking?
Hours

Minutes

11 Variable

Now, think about the time you spent SITTING on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, traveling on a bus or sitting or lying down to watch television.

12 Variable (Q4A)

During the last 7 days, how much TIME IN TOTAL did you usually spend sitting on a WEEK DAY? [PER DAY TOTAL] [PROMPT IF REQUIRED] Include time spent lying down (awake) as well as sitting] [IF PATTERN OF TIME SPENT LYING DOWN VARIES WIDELY FROM DAY TO DAY, ASK] What is the average time spent per day sitting or lying down? [ANSWER IN HOURS AND MINUTES]

Hours

Minutes

13 Variable (Q4B)

During the last 7 days, how much TIME IN TOTAL did you usually spend sitting on a WEEK-END DAY? [PER DAY TOTAL] [PROMPT IF REQUIRED] Include time spent lying down (awake) as well as sitting] [IF PATTERN OF TIME SPENT LYING DOWN VARIES WIDELY FROM, ASK] What is the average time spent on the weekend sitting or lying down? [ANSWER IN HOURS AND MINUTES]

Hours

Minutes

14 Variable

The next three questions are more general questions about your participation in physical activity. These questions will ask you to select from five different options, please wait until I have told you all five options before answering.

The first question is about your USUAL level of physical activity and your INTENTION to be active in the future. Think about ALL the physical activity you do in a week.

15 Variable

Do you participate in moderate and or vigorous physical activity on MOST days of the week for around 30 minutes or more each time? [READ OPTIONS]

- Q5AA YES, and I have been for MORE than 6 months
- Q5AB YES, and I have been, but for LESS than 6 months
- Q5AC NO, but I intend to in the next 30 days
- Q5AD NO, but I intend to in the next 6 months
- Q5AE NO, and I do NOT intend to in the next 6 months

16 Variable (Q6A)

The next question is, how active do you think you are NOW as compared with 3 months ago? [THE TIME WHEN WE CONDUCTED THE LAST SURVEY]

[READ OPTIONS]

- 1 Much more active
- 2 A little more active
- 3 About the same
- 4 A little less active
- 5 Much less active
- 6 CANT SAY
- 7 REFUSED TO ANSWER

17 Variable (Q7A)

In the past week, have you had any health problems that may have significantly limited your ability to be physically active?

- 1 Yes
- 2 No [Jump to 19]
- 3 CANT SAY [Jump to 19]
- 4 REFUSED TO SAY [Jump to 19]

18 Variable (Q7AA)

Could you please tell me what it was?

19 Variable

The next set of questions will ask you about any information resources you may have seen about physical activity in the past 3 months.

20 Variable (Q8A)

Within the last 3 months have you received any letters in the internal mail on the 'Active Living' project?

1 Yes

2 No

3 CANT SAY

[Jump to 24]

[Jump to 24]

21 Variable (Q8B)

How many letters do you recall receiving?

1 None

2 One

3 Two

4 Three

5 Four

6 More than four

7 DONT KNOW

[Jump to 24]

22 Variable (Q9A)

Of the letters you received how much of them did you read? [READ OPTIONS]

1 None of them

2 Some of them

3 About half of them

4 Most of them

5 All of them

6 REFUSED TO SAY

23 Variable (Q10A)

How useful were the letters you received? [READ OPTIONS]

1 Not at all useful

2 A little useful

3 Moderately useful

4 Quite useful

5 Extremely useful

6 CANT SAY

7 REFUSED TO SAY

24 Variable (Q11A)

Within the last 3 months have you seen any booklets about physical activity?

- 1 Yes
- 2 No [Jump to 26]
- 3 DONT KNOW [Jump to 26]

25 Variable

What were the booklets called?

- Q11AA Active living booklets
- Q11AB Other (specify)
- Q11AC CANT SAY

26 Variable (Q12A)

Within the last 3 months have you seen any coloured booklets with the words 'Active Living' on the cover?

- 1 Yes
- 2 No [Jump to 32]
- 3 CANT SAY [Jump to 32]

27 Variable

Where did you see the Active Living booklets? [READ OPTIONS]

- Q13A They were sent to me
- Q13B A work colleague showed them to me
- Q13C OTHER (Please specify)
- Q13D DONT KNOW [DO NOT READ OUT]

28 Variable (Q14A)

How much of the Active Living booklets did you read? [READ OPTIONS]

- 1 None
- 2 Some of them
- 3 About half of them
- 4 Most of them
- 5 All of them
- 6 REFUSED TO SAY

29 Variable (Q15A)

How useful did you find the Active Living booklets? [READ OPTIONS]

- 1 Not at all useful
- 2 A little useful
- 3 Moderately useful
- 4 Quite useful
- 5 Extremely useful
- 6 REFUSED TO SAY

30 Variable (Q16A)

What did you do with the Active Living booklets? [READ OPTIONS]

- 1 Stored them away
- 2 Left them out in a prominent place
- 3 Threw them out
- 4 Lost them
- 5 Gave them away
- 6 OTHER(please specify) [Q16AA (C 40)]
- 7 DONT KNOW
- 8 REFUSED TO SAY

31 Variable

Have you discussed the Active Living booklets with anyone else? [IF YES CONFIRM BY READING FIRST 3 OPTIONS]

- Q17A Yes, with work colleagues
- Q17B Yes, with family
- Q17C Yes, with friends and acquaintances
- Q17D No

32 Variable (EMAIL)

How often would you usually access your University e-mail? [READ OPTIONS]

- 1 Several times a day
- 2 At least once a day
- 3 Twice a week
- 4 At least once a week
- 5 Less than once a week

33 Variable (Q18A)

Within the last 3 months have you received any e-mails on the 'Active living' project?

- 1 Yes
- 2 No [Jump to 37]
- 3 DONT KNOW [Jump to 37]
- 4 REFUSED TO SAY [Jump to 37]

34 Variable (Q18B)

How many e-mails do you recall receiving? [DO NOT READ OUT]

- 1 None [Jump to 37]
- 2 One
- 3 Two
- 4 Three
- 5 Four
- 6 More than four

7 DONT KNOW

35 Variable (Q19A)

Of the e-mails you received how much of them did you read? [READ OPTIONS]

- 1 None**
- 2 Some of them**
- 3 About half of them**
- 4 Most of them**
- 5 All of them**
- 6 REFUSED TO SAY**

[Jump to 37]

36 Variable (Q20A)

How useful were the e-mails you received? [READ OPTIONS]

- 1 Not at all useful**
- 2 A little useful**
- 3 Moderately useful**
- 4 Quite useful**
- 5 Extremely useful**
- 6 REFUSED TO SAY**

37 Variable (Q21A)

Within the last 3 months have you seen any web sites about physical activity?

- 1 Yes**
- 2 No**
- 3 DONT KNOW**
- 4 REFUSED TO SAY**

[Jump to 39]

[Jump to 39]

[Jump to 39]

38 Variable

What was the web site called or about?

- Q22A Active Living Project**
- Q22C Other (specify)**
- Q22B NONE**

39 Variable (Q23A)

[Skip If (q22a=1) .or. ((q22a = 1) .and. (q22c=1))]

Within the last 3 months have you seen a web site called Active Living?

- 1 Yes**
- 2 No**
- 3 DONT KNOW**

[Jump to 48]

[Jump to 48]

40 Variable

How did you come to know about the 'Active Living' website? [INTERVIEWER READ
OPTIONS]

- Q24A The web site address was sent to me**

Q24B A work colleague showed it to me
Q24C Other (please specify)
Q24DDD DONT KNOW

41 Variable

Have you had any of the following difficulties trying to access the 'Active Living' Website, please answer Yes or No to the following statements?[INTERVIEWER READ OPTIONS]

WEB1 My USUAL email username and password would not work.
WEB2 The username and password GIVEN TO ME would not work.
WEB3 I have limited time to access a computer at work.
WEB4 I am not experienced enough at using the computer.
WEB5 The University web server was slow or not working.
WEB6 Any other reason, please specify.
WEB7 NONE OF THE ABOVE

42 Variable (Q28A)

Were you able to access the Active Living website?

1 Yes (How many times) [Q28AA (N 3)]
2 No

43 Variable (Q25A)

[Skip If q28a = 2]

There were 4 different sections to the Active Living web-site. How many of these sections did you visit and read? [READ OPTIONS]

1 None
2 One
3 Two
4 Three
5 Four
6 CANT RECALL

44 Variable (Q26A)

[Skip If q28a = 2]

How useful did you find the Active Living web site? [READ OPTIONS]

1 Not at all useful
2 A little useful
3 Moderately useful
4 Quite useful
5 Extremely useful
6 CANT SAY
7 REFUSED TO SAY

45 Variable (Q27A)

Did you add the Active Living web site to your 'Favourites' or 'Bookmarks' folder so you could easily access it?

- 1 Yes
- 2 No
- 3 CANT RECALL
- 4 REFUSED TO SAY

46 Variable (Q29A)

[Skip If q28a = 2]

Did you print out any information from the Active Living web site?

- 1 Yes
- 2 No
- 3 CANT RECALL
- 4 REFUSED TO SAY

47 Variable

Have you discussed the Active Living web site with anyone else? [IF YES CONFIRM BY READING FIRST 3 OPTIONS]

- Q30A Yes, with work colleagues
- Q30B Yes, with family
- Q30C Yes, with friends and acquaintances
- Q30D No

48 Variable (Q31A)

The next question is about your preferences for receiving information about physical activity. If you could get the same information about physical activity through web sites and emails or through booklets and letters, which would you prefer? [READ OPTIONS]

- 1 Web sites and emails
- 2 Booklets and letters
- 3 No preference
- 4 OTHER

49 Variable (Q32A)

How confident are you about using computers to access information? [READ OPTIONS]

- 1 Not at all confident
- 2 Slightly confident
- 3 Moderately confident
- 4 Confident
- 5 Very confident

50 Variable (TRAVWO)

The next set of questions relate to the time you spend travelling to and from work. On the days that you come to work, how much time do you usually spend travelling TO work? [GIVE ANSWER IN HOURS AND MINUTES]

Hours

Minutes

51 Variable (WALKCY)
How much of THAT time is spent either walking or cycling? [ANSWER IN MINUTES]

52 Variable (HOMEW)
On the days that you come to work, how much time do you usually spend travelling HOME from work? [ANSWER IN MINUTES]
Hours

Minutes

53 Variable (HOMEWC)
How much of THAT time is spent either walking or cycling? [ANSWER IN MINUTES]

54 Variable (WALKDA)
Do you ever walk for exercise or recreation DURING your BREAKS AT WORK? [IF YES, THEN CONFIRM FREQUENCY]

1 Yes everyday (5DAYS)	
2 Yes on most days (3 or 4 DAYS)	
3 Yes sometimes (1 or 2 DAYS)	
4 Never	[Jump to 56]
5 REFUSED TO SAY	[Jump to 56]

55 Variable (WALBRE)
When you walk for exercise or recreation DURING your BREAKS AT WORK, how much time do you usually spend walking? [ANSWER IN MINUTES]

56 Variable
The following questions will ask you about any environmental factors related to walking in and around your neighbourhood.

57 Variable (WALKXW)
How many times a week do you go for a walk for any reason (for eg, for exercise, doing errands, walking for transport) in and around your neighbourhood? [TIMES PER WEEK]

58 Variable (WALKMI)
How much time would you usually spend walking when you do go for a walk in and around your neighbourhood? [ANSWER IN MINUTES]

59 Variable
The following questions will ask about how you would rate aspects of your home neighbourhood that might influence whether or not you walk.
Please give each aspect a rating on a scale of 1 to 10, where 1 or 2 would be a low rating and 9 or 10 would be a high rating.

60 Variable (Q33A)

How would you rate the general friendliness of the people who you see when you are out and about in your neighbourhood?

On a scale of 1 to 10, where 1 is not at all friendly and 10 is very friendly. [CONFIRM ANSWER ON A SCALE OF 1 TO 10].

- 1 Not at all friendly**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**
- 10 Very Friendly**

61 Variable (Q33B)

How enjoyable is the scenery for walking? On a scale of 1 to 10, where 1 is not at all enjoyable and 10 is very enjoyable. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Not at all enjoyable**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**
- 10 Very enjoyable**

62 Variable (Q33C)

How would you rate the walking distance to shops in your neighbourhood? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Very far away**
- 2 .**
- 3 .**
- 4 .**
- 5 .**
- 6 .**
- 7 .**
- 8 .**
- 9 .**

10 Very close

63 Variable (Q33D)

How would you rate the walking distance to a park or beach? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

1 Very far away

2 .

3 .

4 .

5 .

6 .

7 .

8 .

9 .

10 Very close

64 Variable (Q33E)

How would you rate the walking distance to a bus stop or train station? On a scale of 1 to 10, where 1 is very far away and 10 is very close. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

1 Very far away

2 .

3 .

4 .

5 .

6 .

7 .

8 .

9 .

10 Very close

65 Variable (Q33F)

How much of a problem is traffic when walking in your neighbourhood? On a scale of 1 to 10, where 1 is a very a big problem and 10 is no problem at all. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

1 Very big problem

2 .

3 .

4 .

5 .

6 .

7 .

8 .

9 .

10 No problem at all

66 Variable (Q33G)

Overall, how convenient is it to walk in your neighbourhood? On a scale of 1 to 10, where 1 is not at all convenient and 10 is very convenient. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Not at all convenient
- 2 .
- 3 .
- 4 .
- 5 .
- 6 .
- 7 .
- 8 .
- 9 .
- 10 Very convenient

67 Variable (Q33I)

How accessible is a path or cycleway for walking? On a scale of 1 to 10, where 1 is not at all accessible and 10 is very accessible. [CONFIRM ANSWER ON A SCALE OF 1 TO 10]

- 1 Not at all accessible
- 2 .
- 3 .
- 4 .
- 5 .
- 6 .
- 7 .
- 8 .
- 9 .
- 10 Very accessible

68 Variable (Q35A)

That completes the formal part of the survey, however, there is just two more questions I would like to ask. Would you be willing to participate in a similar survey in approximately four months time?

- 1 Yes
- 2 No

69 Variable (Q35B)

Would you be willing to continue receiving some resources about physical activity in the mail or via the internet?

- 1 Yes
- 2 No

70 Variable

That completes the survey. I would like to thank you for your time and cooperation.

APPENDIX B-4

Community study baseline survey

Consent

Information contained in the survey will be kept in the strictest confidence. It will only be made available to the research team at the University of Wollongong. Individual information that identifies you will not be available to Fund staff or be used for any other commercial purpose. Combined information that cannot be linked to you will only be used for evaluation of the Program. Please tick the box below to consent to this use of the information and sign where marked.

☐ Yes *I understand that identifying information contained in this form will be available only to the research team at the University of Wollongong.*

Signature _____ Date _____

BY RETURNING THIS SURVEY WITHIN 10 DAYS, YOU WILL BE SENT A FREE WATER BOTTLE as a thank you. After completing the survey, simply place it in the pre-paid addressed envelope and put it in the mail. All results from the survey will be reported anonymously.

This survey asks questions about how you rate aspects of your neighbourhood that can make it more, or less, easy to walk. Please follow the example below and place a tick in the appropriate place between the statements.

EXAMPLE ONLY walking in my neighbourhood is very difficult ☒ very easy

We want to know **how close or convenient places are for walking in your neighbourhood**
Think about your neighbourhood, read both statements and place a tick between the statements in the place that is most true for you

1	A path or cycleway: is not convenient for walking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is very convenient for walking
2	Local park: is not convenient for walking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is very convenient for walking
3	Lake or beach: is not within walking distance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is within easy walking distance
4	Public transport: is too far to walk to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	is very close to walk to
5	Shops: are too far to walk to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	are very close to walk to
6	Overall, there is nowhere convenient to walk	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	there are very convenient places to walk
		1	2	3	4	5	6	7	8	9	10

We want to know, **do you feel your neighbourhood is pleasant for walking?** Think about your neighbourhood, and place a tick between each set of statements in the place that is most true for you

7	No enjoyable scenery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	a lot of enjoyable scenery
8	Not at all attractive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	very attractive neighbourhood
9	Not at all friendly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	very friendly (you can say hello)
10	No-one to walk with	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	there are many people I can walk with
11	A lot of litter in the streets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	streets are free from litter
12	Not at all pleasant for walking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	very pleasant for walking
13	There are no trees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	there are a lot of trees
14	I have to walk the same route to get to places (I have to go the same way each time)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	there are many different routes I can take
		1	2	3	4	5	6	7	8	9	10

[illegible]

- The next questions involve telling us a little about yourself.** This information is important for us to be able to identify some of the ways in which people are different. Please tick the appropriate answer.

The next questions involve telling us a little about yourself. This information is important for us to be able to identify some of the ways in which people are different. Please tick the appropriate answer.

27. What is the highest level of education you have completed?
- | Year 10 or less | Year 12 | TAFE/ Trade | University |
|-----------------|---------|-------------|------------|
| | | | |

30. In the past week, have you had any health problems that limited your ability to walk?

31a. How many times a week do you go for a walk for any reason (for exercise, doing errands, walking to get to places) in and around your neighbourhood?

average times per week

31b. On average, how many **minutes per time** would you usually spend when walking in and around your neighbourhood?

minutes

For all the reasons listed below, during a USUAL week, please **estimate** the number of times you spent walking in your neighbourhood or elsewhere for **at least 10 minutes at a time**. Write your answer in the **first column**.
Next, write how many **minutes per time** you walked in the **next column**.

Then please look at the effort scale and insert a number to match YOUR effort in the last column.

Activity (for more than 10 minutes continuously each time)	Average number of times a week (for more than 10 minutes at a time)	Average number of minutes EACH time	Effort your walking (or other activity) takes
32. Walking for exercise			
33. Social or pleasure walking			
34. Walking to get from place to place (eg walking to a shop, or bus stop)			
35. Walking as part of your everyday work			
36. Other forms of exercise you do (eg team sport, gym)			

At what pace do you usually walk? Please choose the number that is closest to *your usual* pace or effort:

- 1 - **Slow** pace- going for a very gentle stroll
- 2 - **Light** pace- walking slowly at your own pace
- 3 - **Moderate** pace- not especially hard, it feels fine, no problem to continue
- 4 - **Hard** pace- it feels hard, you are tired, but don't have great difficulties going on
- 5 - **Very hard** pace- you have to push yourself very much, you are very tired

37. **Think about ALL the physical activity you do in a usual week.** Do you participate in physical activity on **MOST** days of the week for around 30 minutes or more each time? Please tick the answer that best applies to you:

- YES, and I have been for MORE than 6 months
- YES, and I have been but for LESS than 6 months
- NO, but I intend to in the next 30 days
- NO, but I intend to in the next 6 months
- NO, and I do NOT intend to in the next 6 months

Now, simply place the survey in the supplied pre-paid envelope and put it in the mail. If you return the survey within 10 days you will be sent a FREE WATER BOTTLE AS A REWARD. To send this reward, we need you to print your name and address below. Thank you in advance for your time and effort, and be assured that your information is valuable and will be used to benefit the people of the Illawarra.

Name: _____
Address: _____
Health Fund Membership Number _____

APPENDIX B-5

Community study follow-up survey

This survey is a follow-up to the one you answered 8 weeks ago. Thank you for completing the first survey and being part of the study. This final survey repeats a number of questions from the first survey. This is important for comparison purposes; we want to know what may have changed over the last 8 weeks. Please answer as you see things now.

IF YOU RETURN THIS SURVEY WITHIN 10 DAYS, YOU WILL BE SENT A FREE COPY OF THE CURRENT HEARTWISE JOURNAL.

After completing the survey, simply place it in the pre-paid envelope and put it in the mail.

Please follow the example below and place a tick in the appropriate place between the statements.

EXAMPLE ONLY **walking in my neighbourhood is**

Very difficult ✓ very easy

We want to know how close or convenient places are for walking in your neighbourhood.

Read both statements, think about your neighbourhood, and place a tick between the statements in the place that is most true for you.

1	A path or cycleway: is not convenient for walking	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	is very convenient for walking
2	Local park: is not convenient for walking	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	is very convenient for walking
3	Lake or beach: is not within walking distance	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	is within easy walking distance
4	Public transport: is too far to walk to	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	is very close to walk to
5	Shops: are too far to walk to	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	are very close to walk to
6	Overall, there is nowhere convenient to walk	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	there are very convenient places to walk
		1	2	3	4	5	6	7	8	9	10						

We want to know, do you feel your neighbourhood is pleasant for walking? Think about your neighbourhood, and place a tick between each set of statements in the place most true for you.

7	No enjoyable scenery	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	a lot of enjoyable scenery
8	Not at all attractive	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	very attractive neighbourhood
9	Not at all friendly	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	very friendly (you can say hello)
10	No-one to walk with	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	there are many people I can walk with
11	A lot of litter in the streets	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	streets are free from litter
12	Not at all pleasant for walking	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	very pleasant for walking
13	There are no trees	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	there are a lot of trees
14	I have to walk the same route to get to places (I have to go the same way each time)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	there are many different routes I can take
		1	2	3	4	5	6	7	8	9	10						

When walking in your neighbourhood

- [illegible]

25. Are you? Male Female
26. How old were you last birthday? _____ years

For our follow-up survey, we need to ask you again about the physical activities you do as part of your everyday life.

26. **Think about ALL the physical activity you do in a usual week.** Do you participate in physical activity on **MOST** days of the week for around 30 minutes or more each time? Please tick the answer that best applies to you:

YES, and I have been for MORE than 6 months

YES, and I have been but for LESS than 6 months

NO, but I intend to in the next 30 days

NO, but I intend to in the next 6 months

NO, and I do NOT intend to in the next 6 months

- 27a. How many times a week do you go for a walk for any reason (for exercise, doing errands, walking to get to places) in and around your neighbourhood only?

average times per week

- 27b. On average, how many **minutes per time** would you usually spend when walking in and around your neighbourhood?
minutes

For all the reasons listed below, during a USUAL week over the last 8 weeks, please **estimate** the number of times you spend walking in your neighbourhood and elsewhere **for at least 10 minutes at a time**, and write in the **first column**.
 Next, write how many **minutes per time** you walked in the **next column**.
 Then please **look at the effort scale** and insert a number to match **YOUR effort** in the **last column**

Activity (for more than 10 minutes continuously each time)	Average number of times a week (for more than 10 minutes at a time)	Average number of minutes EACH time	Effort your walking (or other activity) takes➡
28. Walking for exercise			
29. Social or pleasure walking			
30. Walking to get from place to place (eg walking to a shop, or bus stop)			
31. Walking as part of your everyday work			
32. Other forms of exercise you may do (eg team sport, gym)			

At what pace do you usually walk? Please choose the *number* that is closest to *your* pace or effort

1 - **Slow** pace- going for a very gentle stroll

2 - **Light** pace- walking slowly at your own pace

3 - **Moderate** pace- not especially hard, it feels fine, no problem to continue

4 - **Hard** pace- it feels hard, you are tired, but don't have great difficulties in going on

5 - **Very hard** pace– you have to push yourself very much, you are very tired

33. How much walking do you think you are doing **NOW** as compared with 8 weeks ago (when we conducted the last survey)?

Please circle the number that is most suited to your answer

1

2

3

4

5

much more a little more about the same a little less much less

34. Within the past 8 weeks, do you remember receiving any brochures about walking?

Yes No

34a. How many do you recall receiving? Please circle one of the following options:

None One Two Three

35. Of the brochures you received, how many did you read? Please circle one option:

None One Two Three

36. How useful were the brochures you received? Please circle an option:

1	2	3	4	5
not at all	a little	moderately	quite useful	extremely

37. How much did the weekly brochure influence your walking participation?

1	2	3	4	5
not at all	a little	moderately	quite a lot	very much

Answer the next 2 questions only if you received telephone advice calls

38. How useful were the telephone advice calls to you?

1	2	3	4	5
not at all	a little	moderately	quite useful	extremely

39. How much did the telephone calls influence your walking participation?

1	2	3	4	5
not at all	a little	moderately	quite a lot	very much

When you have completed the survey, simply place it in the pre-paid envelope and put it in the mail. IF YOU RETURN THE SURVEY WITHIN 10 DAYS, YOU WILL BE SENT A **FREE** COPY OF THE CURRENT HEARTWISE JOURNAL. Thank you for taking part in “Walking for Health & Well-being”. Be assured that all information will be reported anonymously, but **we do need your name and address to send you the reward and match up with the first survey.**

Name: _____

Address: _____

Membership number: _____

APPENDIX B-6

Full list of items measuring environmental perceptions from Part 4

APPENDIX B-6: Perceived Environmental Attributes Measured in the Studies of Part 4, Factor Groupings and Response Options.

1	A path or cycleway: is not convenient for walking	—	—	—	—	—	is very convenient for walking
2	Local park: is not convenient for walking	—	—	—	—	—	is very convenient for walking
3	Lake or beach: is not within walking distance	—	—	—	—	—	is within easy walking distance
4	Public transport: is too far to walk to	—	—	—	—	—	is very close to walk to
5	Shops: are too far to walk to	—	—	—	—	—	are very close to walk to
6	Overall, there is nowhere convenient to walk	—	—	—	—	—	there are very convenient places to walk
7	No enjoyable scenery	—	—	—	—	—	a lot of enjoyable scenery
8	Not at all attractive	—	—	—	—	—	very attractive neighbourhood
9	Not at all friendly	—	—	—	—	—	very friendly (you can say hello)
10	No-one to walk with	—	—	—	—	—	there are many people I can walk with
11	A lot of litter in the streets	—	—	—	—	—	streets are free from litter
12	Not at all pleasant for walking	—	—	—	—	—	very pleasant for walking
13	There are no trees	—	—	—	—	—	there are a lot of trees
14	I have to walk the same route to get to places (I have to go the same way each time)	—	—	—	—	—	there are many different routes I can take
15	Crossing busy roads is a big problem	—	—	—	—	—	crossing busy roads is not a problem
16	Streets nearby are hilly, making it difficult to walk	—	—	—	—	—	streets are flat to walk
17	Traffic makes it dangerous or unpleasant	—	—	—	—	—	traffic is not a problem
18	I don't feel at all safe	—	—	—	—	—	I feel very safe
19	Dogs always put me off walking	—	—	—	—	—	dogs never put me off walking
20	Footpaths are unsafe (eg.cracks) or there are none	—	—	—	—	—	footpaths are even, with no cracks
21	Rainy weather always prevents me from walking	—	—	—	—	—	rain never prevents me from walking
22	Cold weather always prevents me from walking	—	—	—	—	—	cold weather never prevents me walking
23	Hot weather always prevents me from walking	—	—	—	—	—	hot weather never prevents me walking
24	Windy weather always prevents me from walking	—	—	—	—	—	windy weather never prevents me walking

Aesthetics = items 7,8,9,12 Accessibility = items 1,2,3,4,5,14,16,20 Safety = items 15,17,18,19 Weather = items 21,22,23,24

APPENDIX C-1

Additional Table for the Cross-Sectional Study of Part 4

APPENDIX C-1

Mean Scores and Standard Deviations of Environmental Perception Items

	Sample	Men	Women
Cycleway	6.90 (3.25)	6.94 (3.21)	6.90 (3.25)
Park	6.09 (3.37)	6.12(3.37)	6.11 (3.38)
Lake/beach	5.28 (3.85)	5.18 (3.86)	5.32 (3.84)
Transport	7.69 (2.73)	7.62 (2.72)	7.77 (2.71)
Shops	6.53 (2.88)	6.42 (2.83)	6.61 (2.91)
Convenience	7.96 (2.58)	8.01 (2.43)	7.96 (2.62)
Scenery	8.17 (2.06)	8.20 (1.91)	8.17 (2.11)
Attractive	8.08 (2.04)	8.07 (1.89)	8.11 (2.09)
Friendly	8.23 (2.05)	8.09(1.96)	8.37 (2.02)
Walk with	5.82 (2.94)	5.83 (2.72)	5.83 (3.08)
No litter	7.76 (2.26)	7.58 (2.37)	7.92 (2.17)
Pleasant	8.32 (1.93)	8.19 (1.91)	8.42 (1.92)
More trees	7.86 (2.16)	8.09 (1.96)	7.69 (2.27)
Different routes	7.07 (2.69)	7.05 (2.55)	7.09 (2.77)
No busy roads	7.71 (2.43)	7.52 (2.54)	7.97 (2.26)
Not hilly	5.91 (3.06)	5.89 (3.03)	5.89 (3.07)
Less traffic	7.53 (2.40)	7.36 (2.30)	7.72 (2.41)
Feel safe	8.09 (2.07)	8.44 (1.72)	7.83 (2.27)
Less dogs	7.67 (2.57)	8.00 (2.35)	7.42 (2.69)
Footpaths	5.93 (2.74)	6.06 (2.71)	5.86 (2.75)
Rain	5.12 (2.90)	5.22 (2.85)	5.04 (2.94)
Cold	6.71 (2.72)	6.70 (2.67)	6.72 (2.77)
Hot	6.74 (2.70)	7.07(2.42)	6.48 (2.87)
Windy	6.12 (2.67)	6.35 (2.53)	5.96 (2.76)

Gender differences in mean scores on environmental attributes were evidenced for: ‘feel safe’ $F(1,378)=8.31p<.004$; ‘less dogs’ $F(1,374)=4.77p<.03$; and ‘hot weather’ $F(1,376)=4.54p<.034$

APPENDIX D:

Conference presentation based on the data from the cross-sectional study of Part 3: Associations of objective location and perceived environmental attributes with walking in neighbourhood settings

This appendix includes the accepted abstract and poster presentation for the Seventh International Congress of Behavioural Medicine Conference, 28-31 August, Helsinki, Finland, 2002.

D-1: Accepted abstract

D-2: Handout for poster presentation at the Seventh International Congress of Behavioural Medicine Conference, Helsinki, 2002.

APPENDIX D-1:

ASSOCIATIONS OF OBJECTIVE LOCATION AND PERCEIVED ENVIRONMENTAL ATTRIBUTES WITH WALKING IN NEIGHBOURHOOD SETTINGS

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Bauman AE. School of Community Medicine, University of NSW, Sydney, NSW, Australia.

Ecological models of health behaviour highlight the importance of environmental influences on participation in physical activity. Environmental interventions have potentially great public health benefits. We examined associations of location (identified by postal code) and perceived attributes of the physical environment (aesthetic nature, convenience of facilities, distance for functional walking and traffic as a problem) with neighbourhood walking, total walking and total physical activity. Participants were 800 University staff from a small (regional) city in Australia, who were interviewed by telephone. In our main analysis all environmental attributes were adjusted for simultaneously in a combined logistic regression model. Men were significantly more likely to be in the high level of neighbourhood walking if they lived in a coastal location (odds ratio [OR] =1.66), and had high ratings in the 'aesthetics' (OR =1.91), 'convenience' (OR =2.20) and 'functional' (OR =1.98) perceived environment categories. Women were significantly more likely to be in the high category of neighbourhood walking if they had high ratings for 'convenience' (OR =3.78) environment category, and were significantly less likely to be in the high neighbourhood walking category if they had high ratings for 'functional' (OR =0.48) environment category. For total walking and total physical activity, few significant associations emerged. Specific behavioural outcomes such as neighbourhood walking are helpful to identify environmental influences on physical activity. Large gender differences were found in this study; understanding these gender differences in physical activity participation should be a research priority.

APPENDIX D-2

Handout for poster presentation at the Seventh International Congress of
Behavioural Medicine Conference, Helsinki, 2002.



University of
Wollongong



Associations of Location and Perceived Environmental Attributes with Walking in Neighbourhoods

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INTRODUCTION

Public health initiatives to promote physical activity include environmental change strategies^{1,2}. The aim is to reduce barriers by creating suitable activity settings³. As there is now a strong public health focus on regular moderate-intensity activity⁴, we focused on correlates of the most common physical activity, the specific behaviour of walking. We expected neighbourhood environment variables to be more related to walking in the neighbourhood than walking in general or total physical activity⁵.

OBJECTIVES

To examine associations of perceived attributes of the physical environment and coastal versus non-coastal place of residence with neighbourhood walking, total walking and total physical activity.

METHODS

Participants

800 Australian University staff interviewed by telephone (48% women; mean age = 43 years).

Environmental attributes

Objective location by postal code (coastal vs non-coastal) ⁶
Perceived environmental attributes -- 'aesthetics', 'convenience' of facilities, 'access' to services and 'traffic' as a problem.

Physical activity behaviour

A specific self-reported neighbourhood walking item asked "How many times a week do you go for a walk for any reason (e.g., for exercise, doing errands, walking for transport) in and around your neighborhood?"

Self reported leisure-time physical activity was assessed using IPAQ short form, which asks about vigorous-intensity, moderate-intensity and walking separately [see <http://www.ipaq.ki.se/>]
All outcome variables were dichotomized at the median.

RESULTS

FIGURE 1: Odds ratios for the likelihood of being in the highest level of neighbourhood walking, as a function of perceived environmental attributes for MEN (*odds ratio significant)

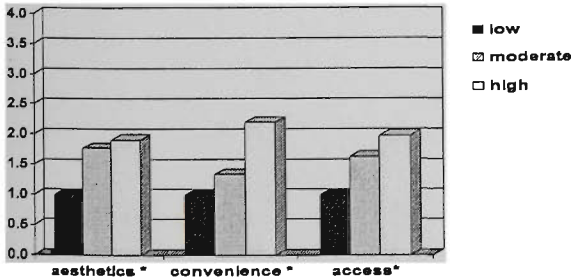
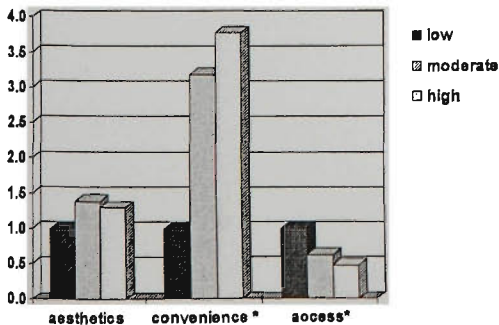


FIGURE 2: Odds ratios for the likelihood of being in the highest level of neighbourhood walking, as a function of perceived environmental attributes for WOMEN (*odds ratio significant)



A stronger set of associations was found for men than for women (Table 1).

Men were 1.66 times (95%CI 1.04-2.67) more likely to be in the high neighbourhood walking category if they lived in a coastal location. There was no association for women.

There were few significant associations with total walking and total physical activity.



Table 1: Odds ratios for location and each category of environmental variables and the likelihood of being in the higher category of neighbourhood walking (* p<.05; ** p<.01; *** p<.001)

MEN	Neigh/ hood walk	Total walk	Total physical activity
Location			
Non-coastal	1.00	1.00	1.00
Coastal	1.66*	1.01	1.12
Aesthetics			
Low	1.00	1.00	1.00
Moderate	1.77*	1.29	1.10
High	1.91*	1.69	1.56
Convenience			
Low	1.00	1.00	1.00
Moderate	1.34	1.08	0.97
High	2.20**	1.37	1.82*
Access			
Low	1.00	1.00	1.00
Moderate	1.83	1.57	0.87
High	1.98*	2.09**	1.55
Traffic			
Big problem	1.00	1.00	1.00
Mod problem	0.94	0.68	0.77
No problem	0.45**	0.79	0.77

WOMEN	Neigh/ hood walk	Total walk	Total physical activity
Location			
Non-coastal	1.00	1.00	1.00
Coastal	0.99	1.00	0.99
Aesthetics			
Low	1.00	1.00	1.00
Moderate	1.40	1.15	0.78
High	1.30	1.44	1.25
Convenience			
Low	1.00	1.00	1.00
Moderate	3.19***	1.51	1.24
High	3.78***	1.37	1.12
Access			
Low	1.00	1.00	1.00
Moderate	0.82	1.92*	1.25
High	0.48*	1.12	1.24
Traffic			
Big problem	1.00	1.00	1.00
Mod problem	0.81	0.95	0.79
No problem	0.95	1.04	0.90

DISCUSSION

By focusing on a particular behaviour, and measuring objective and perceived environmental attributes appropriate for that behaviour, a clearer picture emerges of environment-physical activity behaviour relationships.

The clear associations found for 'aesthetics', 'convenience' and 'access' categories, and the less clear association for 'traffic' demonstrate the need for separate measures for different environmental attributes.

Our findings also highlight the importance of examining gender specific associations for both perceived measures and objective (location) measures of the environment.

The associations of neighbourhood environment characteristics with neighbourhood walking demonstrates the importance of the physical environment when considering public health strategies to increase physical activity participation.

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APPENDIX E

**Accepted abstract from conference presentation based on the data
from the cross-sectional studies of Parts 3 and 4: Perceptions of the
Environment and Walking Behaviour**

This appendix includes the accepted abstract for the symposium “Understanding How Environments Influence Physical Activity” presented at the conference of the Australasian Society for Behavioural Health and Medicine, 13-18 February, Brisbane, Queensland, 2003.

PERCEPTIONS OF THE ENVIRONMENT AND WALKING BEHAVIOUR

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Environmental and policy initiatives to promote physical activity require supportive evidence that environmental factors are related to behaviour. An earlier study with a working population (n = 800) explored associations for four categories of perceived attributes of the environment with the specific behaviour of neighbourhood walking. For men, neighbourhood walking was associated with high ratings of 'aesthetics', 'convenience' and 'access' to services. For women, greater neighbourhood walking was associated with high ratings of 'convenience'. We subsequently recruited a broader community sample (n = 399), with the aim of replicating these findings and also to examine possible specific associations with walking for exercise and walking for pleasure. For men, those with a high rating of 'aesthetics' were more likely to engage in neighbourhood walking (OR= 6.02). For walking for exercise, men were significantly more likely to be in the high category if they gave a high rating for 'aesthetics' (OR= 7.13), and a moderate rating for 'access' (OR=2.64). No significant relationships were found among women. These finding partially replicate those of our earlier study; perceived environmental 'aesthetics' was a strong predictor of walking and clear gender differences were found. The differences may be due to the community sample being older and having less formal education than the worksite sample.