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Individual, Psychosocial and Environmental Correlates of Four-Year Declines
in Walking among Middle-to-Older Aged Adults

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ABSTRACT

Background We examined associations of individual, psychosocial and environmental characteristics with four-year changes in walking among middle-to-older aged adults, since few studies have employed prospective designs.

Methods Walking for transport and walking for recreation were assessed during 2003-2004 (baseline) and 2007-2008 (follow-up) among 445 adults aged 50-65 years residing in Adelaide, Australia. Logistic regression analyses examined predictors of being in the highest quintile of decline in walking (21.4 minutes/day or more reduction in walking for transport; 18.6 minutes/day or more reduction in walking for recreation).

Results Decline in walking for transport was related to higher level of walking at baseline, low perceived benefits of activity, low family social support, a medium level of social interaction, low sense of community, and higher neighborhood walkability. Decline in walking for recreation was related to higher level of walking at baseline, low self-efficacy for activity, low family social support, and a medium level of available walking facilities.

Conclusions Declines in walking for transport and walking for recreation have differing correlates, for which particular preventive strategies may be developed. Prospective association between walkability and walking for transport may support the importance of environmental intervention.

1 INTRODUCTION

2 Promoting physical activity is a public health priority.¹ In order to develop effective programs
3 and policies, it is important to identify the underlying factors associated with physical
4 activity.² Consistent demographic, psychological, behavioral, and social correlates of overall
5 physical activity have been identified for the general adult population.³ Individual-level
6 interventions have sometimes proven beneficial, however, structured programs can be offered
7 to limited numbers of participants and effects often dissipate after the intervention.⁴
8 Ecological models posit that specific physical activity behaviors depend on individual
9 (biological, psychological), social/cultural, physical environmental and policy factors, and
10 that multi-level interventions, targeting both people and environments, should be most
11 effective in changing behavior.⁵ The built environment, including availability of and access to
12 facilities, safety, aesthetics,^{6, 7} and neighborhood walkability,^{8, 9} is of particular interest as a
13 potential determinant of physical activity, as it is amenable to change through community-
14 based initiatives and policy innovations.

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16 Walking is a popular, common form of physical activity,^{10, 11} and is a central element in
17 public health strategies to promote more active lifestyles.^{12, 13} Walking for transport and
18 walking for recreation both can contribute to adults' total physical activity.¹⁴ Despite a wide
19 range of preventive benefits of walking, particularly for those who are middle-aged and
20 older,^{11, 15} adults tend to decrease their walking behaviors as they age.¹⁴

21
22 Multiple studies have examined cross-sectional associations of built environmental attributes
23 with walking.¹⁶ Some such studies have compared different domains of activity, for example,
24 walking for transport versus recreation, and have found particular environmental
25 characteristics related to each,¹⁷⁻¹⁹ indicating the need to distinguish between walking for

transport and walking for recreation. However, few studies have examined concurrently the potential individual, psychosocial and environmental factors related to walking and few have examined walking for particular purposes separately.²⁰⁻²² Furthermore, although the maintenance of physical activity is important to sustain health benefits, studies have been limited largely to the correlates of physical activity at one point in time.³

This study examined the associations of individual (demographic, health status and behavioral), psychosocial and environmental characteristics with declines in walking behaviors (walking for transport and walking for recreation) over four years among Australian adults aged 50 years and older.

METHODS

Study Design and Participants

This study is part of an observational epidemiological study (Physical Activity in Localities and Community Environments; PLACE), designed to investigate associations between neighborhood environmental attributes and residents' physical activity. Baseline and follow-up surveys were conducted during the same months of 2003-2004 and 2007-2008, in Adelaide, Australia. The study was planned and conducted according to the guidelines of the Declaration of the Helsinki and was approved by The Behavioural and Social Science Ethics Committee of the University of Queensland.

Detailed methods have been described elsewhere.^{19, 23} Within the Adelaide Statistical Division, 32 neighborhoods were selected based on their walkability (described later) and their socioeconomic status (SES; based on Census data). Each of these neighborhoods

consisted of three to nine contiguous Census Collection Districts (CCDs), which typically contain approximately 250 households each. As a result, 16 neighborhoods were chosen from high- and low-walkable neighborhoods (i.e. the top and bottom 25% of walkability), respectively (total 32 neighborhoods, 156 CCDs). Letters were sent to 250 randomly sampled residential addresses per neighbourhood, inviting one person per household to participate. A reminder letter was sent to those who had not returned the questionnaire within 3 weeks both in baseline and follow-up survey. Those who met the eligibility criteria (living in private dwellings, aged 20 to 65, able to walk without assistance, and able to speak English) and agreed to participate were sent a questionnaire; 2650 eligible participants from 154 CCDs returned the baseline questionnaire. The overall response rate, as a percentage of all residential addresses (both eligible and ineligible) in the sampling frame, was 11.5%. The response rate could not be quantified as a percentage of eligible households, however, much apparent ‘non-response’ may have been due to ineligibility; at least 25% of households in the sampling frame are unlikely to have contained participants of the required age.^{23, 24} Of those who completed the baseline survey and did not move to another CCD, 41.4% (n=1098) participated in the four-year follow-up. The current study focuses on respondents to both surveys aged over 50 years for whom complete data on walking (n=504) and all relevant covariates (n=445) were available.

Measures

Outcomes

Walking for transport and walking for recreation were assessed using the long form of the International Physical Activity Questionnaire (IPAQ).²⁵ The average duration (minutes/day) of each type of walking was calculated, following IPAQ protocols.²⁶ For both types of walking, change scores were calculated (follow-up minus baseline). Those in the bottom

quintile of change (i.e., the 20% of participants with the most decline) were classified as having experienced a decline; other participants were classed as not declining. Decline corresponded to a reduction in walking of at least 21.4 min/day (transport) or 18.6 min/day (recreation).

Predictors

Socio-demographics and health status

In the baseline survey, participants provided information on their age, gender, educational attainment, work status, household income and living arrangements. Normal ($<25\text{kg/m}^2$) and overweight or obese ($\geq 25\text{kg/m}^2$) body mass index (BMI) categories were derived from self-reported weight and height. Perceived physical and mental health status were measured using the 12-item short-form health survey (SF-12) version 1²⁷ and scored with weights from the Australian National Survey. The physical component scores (PCS) and mental component scores (MCS) were examined separately as tertiles (high, medium, low).

Psychosocial attributes

Several attributes, assessed only at baseline, were examined: self-efficacy for moderate physical activity,^{28, 29} enjoyment of moderate physical activity,³⁰ perceived benefits of regular physical activity,^{29, 31} perceived barriers to regular physical activity,^{29, 31, 32} social support for physical activity from family and from friends,³³ social interaction,³⁴ sense of community,³⁴ social action with neighbourhood,³⁵ and social cohesion.³⁵ These attributes were examined as tertiles (high, medium, low). Supplementary Appendix A provides descriptions and internal consistencies (Cronbach's α) for these variables.

101 *Environmental attributes*

102 CCD-level SES was assessed by the 2001 Index of Economic Resources, a composite
 103 measure from the Australian Bureau of Statistics.³⁶ Perceived neighborhood environmental
 104 characteristics (walking facilities, aesthetics, safety from traffic, and safety from crime) were
 105 assessed at baseline using the Australian version of Neighborhood Environment Walkability
 106 Scale (NEWS-AU).^{37, 38} Participants were asked to evaluate their local area (i.e. the area
 107 within a 10-15 minute walk from home) by responding on a 4-point scale (1 = strongly
 108 disagree, 4 = strongly agree) to statements regarding environmental attributes.
 109 Supplementary Appendix B describes the NEWS-AU subscales and their internal consistency.
 110 Area SES and NEWS-AU subscales were examined as tertiles. Walkability was examined
 111 objectively at the CCD level using an index (4-40) that is based on dwelling density, street
 112 connectivity, land-use mix, and net retail area ratio data acquired as close as possible to
 113 baseline. Higher scores indicate areas are more conducive to walking.^{8,9}

114

115 **Statistical analyses**

116 Characteristics of those who were lost to follow-up (n=515) and those who participated in the
 117 follow-up survey (n=504), and of those with complete (n=445 out of 504) versus incomplete
 118 (n=59 out of 504) data, were compared using t-tests or Mann-Whitney tests for continuous
 119 variables and chi-square tests for categories.

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121 Logistic regression analyses were used to examine the potential predictors of decline in time
 122 spent walking for transport and walking for recreation. Potential predictors were initially
 123 identified based on associations with the walking outcomes, having adjusted for age, gender,
 124 walking for transport and walking for recreation at baseline (model 1). Variables which
 125 showed some evidence of association ($p < 0.25$) with either outcome were included in further

models. Models were then developed with variables entered in blocks (i.e. demographics and health status, psychosocial attributes, and environmental attributes). Variables not significant at $p < 0.25$ were removed from models, except walking at baseline, age and gender, which were kept in all models. Only the final models are reported.

There was some evidence of area-level variation (having adjusted for individual-level characteristics) in walking for transport but not walking for recreation (likelihood ratio test for the random intercept $p = 0.06$ and $p > 0.99$, respectively). Thus, the final model is reported as a random intercept model for walking for transport; the more parsimonious logistic regression model is reported for walking for recreation. Random intercept models were fitted using maximum likelihood estimation. Significance was set at $p < 0.05$. Analyses were using SAS version 8.2 and Stata version 11.0.

RESULTS

Table 1 shows that more than half of the sample (median age = 57 years) were women (54%), working (53%), overweight (58%) and not living alone (63%) at baseline. Time spent walking for transport and walking for recreation at baseline were both low (medians 13 and 11 minutes per day, respectively) but varied widely. Compared to those lost to follow-up, the study participants had higher walking for recreation at baseline ($p = 0.010$) and were more likely to live in wealthier areas ($p = 0.045$), but differences were small (3 minutes/day, an additional 5% from high SES areas). Very few participants (12%) were excluded from the final model due to incomplete data; however those excluded tended to be slightly older ($p < 0.001$) and slightly less likely to be working ($p < 0.001$; data not shown) at baseline.

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Physical health (PCS), self-efficacy, perceived benefits, social support from family, social interaction, sense of community, walking facilities, aesthetics, safety from traffic, area-level SES, and walkability showed some evidence of association ($p < 0.25$) with one or both walking outcomes, adjusted for baseline walking, age and gender (Supplementary Appendix C).

Table 2 shows the predictors of decline in walking for transport, adjusted for all relevant characteristics. Baseline walking for transport was significantly associated with decline in walking for transport (10% higher odds for each additional minute/day). Social interaction was associated with walking for transport ($p = 0.024$); those with a medium level of social interaction had much lower odds of declining than those with high levels. The lower the level of perceived benefits of physical activity, the higher the odds of declining in walking for transport (p for trend = 0.019), with the odds of decline being more than five-fold lower for those with the least, compared with the most perceived benefits. Lower levels of sense of community were associated with lower odds of declining in walking for transport (p for trend = 0.022), with the odds of decline being over four-fold lower for those with the lowest, compared with the highest levels. Less social support from family was associated with higher odds of decline in walking for transport (p for trend = 0.024); odds of decline were four-fold higher for those with the least, compared with the most, support. Better walkability was associated with lower odds of decline in walking for transport (OR=0.93, 95% CI: 0.88-0.99

for each additional point on the walkability index). Significant associations were not seen for age, gender, baseline walking for recreation, self-efficacy, walking facilities, and aesthetics.

Table 2 shows the independent predictors of decline in walking for recreation, adjusted for all other relevant characteristics. More walking for recreation at baseline was associated with significantly higher odds of decline (6% higher odds for each additional minute/day). Self-efficacy had a significant, but non-linear, association with walking for recreation ($p=0.001$), such that relative to those with the most self-efficacy, those with the least self-efficacy had four-fold lower odds of decline in walking for recreation ($OR=0.25$, 95% CI: 0.08-0.76), while those with a medium level of self-efficacy tended, if anything, to have higher odds of decline ($OR = 2.05$, 95% CI: 0.96-4.35). The less social support from family for physical activity, the lower the odds of declining in walking for transport (p for trend =0.043), with odds being approximately two-fold lower for those receiving the least, compared with the most, support. While not statistically significant (p for trend =0.080), the results were slightly suggestive of an association between walking facilities and decline in walking for recreation; compared with those reporting the most walking facilities, the odds of decline were significantly lower for those with a medium amount of facilities ($OR=2.56$, 95% CI: 1.06-6.16) and two-fold higher (not significant) for those with the fewest facilities. Significant associations with decline in walking for recreation were not seen for age, gender, baseline walking for transport, perceived benefits, social interaction, sense of community, aesthetics, and walkability.

INSERT TABLE 2 ABOUT HERE

DISCUSSION

A number of individual, psychosocial and environmental factors were related to four-year declines in walking among middle-to-older Australian adults. Notably, the correlates of a decline in walking for transport were quite distinct from those for walking for recreation. For walking for transport, higher odds of decline were associated with more transport walking time at baseline and low social support from family; lower odds of decline were associated with low perceived benefits, medium social interaction, low sense of community, and higher neighborhood walkability. For walking for recreation, higher odds of decline were associated with more recreational walking time at baseline and a medium level of available walking facilities; lower odds of decline were associated with low self-efficacy and low social support from family. Only social support from family had associations with both walking outcomes, but the direction of these associations differed. The divergence in findings for each outcome reinforces the importance of a behavior-specific approach, as recommended in a previous review.³⁹

Associations with overall physical activity have been reported frequently for age and overweight/obesity (negative associations) and education, gender (male), income, and perceived health (positive associations) in general adult samples.³ Recreational walking has been reported as more common in women and those who were overweight than their respective counterparts.²¹ Higher SES (measured by education and occupation) has shown positive associations with walking for exercise in adults.²² In this study, no demographic attribute or health status variable showed a significant relationship with changes in either type of walking. Possibly, this is an example of cross-sectional associations not being supported

by longitudinal evidence, however it must also be considered that the outcomes examined are different and the cross-sectional evidence has been based on all adults, not middle-aged and older adults.

The findings also complement the existing literature regarding psychosocial correlates of various physical activity behaviors; some longitudinal findings have supported cross-sectional associations seen previously,³ but again there are some inconsistencies that may owe to key differences in the specific behaviors examined and study populations. Additionally, it must be considered that even though walking is likely to form a large part of the physical activity that the participants are referring to in their responses, the target behaviors (moderate or 'regular' physical activity) for these psychosocial variables are not specific to the walking outcomes examined, and specific behaviors that compete can be displaced or substituted. For example, an association opposite to the one expected could arise if a psychosocial attribute increased the likelihood of performing one physical activity behavior that in turn reduces the opportunity for performing another behavior (such as walking for recreation). The association of less social support from family to perform physical activity with more decline in walking for transport supports previous cross sectional evidence that social support is a correlate of adults' physical activity³ and of leisure-time walking in adults.^{20, 40} The unexpected findings for walking for recreation were at odds with those of previous cross-sectional studies, and require further investigation. Another unexpected finding that requires further examination was an association of fewer perceived benefits of physical activity with less decline in walking for transport; either a null result or a result in the opposite direction would be expected from previous studies of adults' physical activity²⁰ and adults' walking for recreation.²⁰ Null association of self-efficacy with decline in walking for transport was not consistent with the existing evidence for self-efficacy as a

well-established correlate of physical activity in adults;³ the finding for walking for recreation is not wholly unexpected in view of the mixed findings from the literature that has focused on walking for recreation.^{20, 21, 40}

There was some evidence social contacts within the neighborhood had association with change in older adults' walking behavior, however the results did not indicate something as simple as social contacts being universally beneficial. Further exploration is needed to understand why associations were seen only with walking for transport, and seen only with some measures (social interaction and sense of community, but not social action or social cohesion), and why less sense of community, and a medium amount of social interaction appeared to be most beneficial.

A recent review reported both the availability of walking facilities and aesthetics as correlates of walking for recreation;¹⁶ the current study was corroborative of the review's findings for walking facilities only. Null associations of neighborhood safety with both outcomes were not entirely unexpected as the findings in the literature for neighborhood safety have been mixed.¹⁶ The current associations of walkability with declines in walking for transport but not recreation supports cross-sectional associations reported previously for adults generally in the PLACE study.¹⁹ It should be noted that whereas many of individual and psychosocial correlates of physical activity did not show significant associations with their declines in walking behaviors, walkability, one of the built environmental attributes, showed sizable, beneficial associations with change in walking for transport only. Prospective association between walkability and walking for transport may support the importance of environmental intervention.

Limitations of the present study include some selection bias, considering the low response rate, and the substantial loss to follow up, which was not completely random. This study focused on baseline predictors of changes in walking over four years. In further analyses (not reported), changes in predictor variables were also examined whenever the relevant information was available. Examining changes did not alter any of the major study conclusions, possibly in part as minimal change was experienced by sample (e.g. only 62 [12%] of participants retired and 25 [5%] of participants began working over the course of the study). The relevance of changes could be better examined by including interim assessments.

There may also have been measurement error and bias in the self-report measures of walking behaviors; consequently, some “decline” may reflect regression to the mean. Similarly, the association between baseline values and change may simply reflect regression to the mean rather than necessarily indicating that those who were originally more active have greater difficulty to maintain or improve their activity than those who were originally less active. Importantly, this issue is less important for the other correlates of decline, as all associations were tested having adjusted for baseline values.

Nevertheless, in order to interpret the counterintuitive findings on social support from family and perceived benefits, it may help to reconsider the effect of the regression to the mean. Given the “strong” association between baseline values and change (walking for transport at baseline vs. change in walking for transport, and walking for recreation at baseline vs. change in walking for recreation; see Supplementary Appendix D and E, respectively), even though all associations were tested having adjusted for baseline values, there might still remain some effect of the regression to the mean. For example, low social support and low perceived

benefits may relate to low baseline level of walking, and thus may reduce the change in walking over four years. In contrast, this may not be the case for walkability (i.e. one of the key variables of interest in this study); if there still remains some effect of the regression to the mean, low walkability may be associated with low baseline level of walking, and thus may reduce the change in walking. Given that greater walkability was associated with lower odds of decline in walking for transport, it may be unlikely that this association was affected by the regression to the mean. Therefore, not all findings simply reflect regression to the mean.

These findings are the first to document individual, psychosocial and environmental attributes that are independent predictors of changes in walking for transport and walking for recreation in middle-to-older adults. The study's prospective design and behavioral specificity are key strengths and its findings aid in understanding the determinants of declines in walking behaviors among middle-to-older adults. Further prospective studies are required, with more than two observation points, long-term follow-ups and, ideally, objective measurement of physical activity.

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Table 1. Characteristics of study sample and potential participants who were lost to follow-up

	Participants (n=504)		Lost to follow-up (n=515)	
	n		n	
Demographics				
Age (years), Median (25th, 75th percentile)	504	57.0 (53.0, 60.0)	515	57.0 (53.0, 60.0)
Gender (% men)	504	46.0	515	40.6
Education (% tertiary educated)	498	44.0	509	39.2
Work status (% working)	494	52.8	504	54.4
Living arrangement (% single)	494	36.6	498	39.6
Household income	480		492	
% \$1-20,799 per annum		25.8		31.7
% \$20,800-51,999 per annum		42.1		38.4
% \$52,000 or more per annum		32.1		29.9
BMI, Median (25th, 75th percentile) kg/m ²	498	25.7 (23.7, 28.9)	498	26.2 (23.5, 29.9)
Overweight (% BMI $\geq$ 25 kg/m ²)	498	58.1	498	59.8
Behavioral attributes				
Walking for transport at baseline Median (25th, 75th percentile) min/day	504	12.9 (2.9, 34.3)	478	12.9 (0.0, 34.3)
Walking for recreation at baseline Median (25th, 75th percentile) min/day	504	11.1 (0.0, 31.6)	487	8.6 (0.0, 28.6)**
Walking for transport at follow-up Median (25th, 75th percentile) min/day	504	12.9 (4.3, 30.0)	N/A	
Walking for recreation at follow-up Median (25th, 75th percentile) min/day	504	8.6 (0.0, 25.7)	N/A	
Change in walking for transport Median (25th, 75th percentile) min/day	504	0.0 (-14.3, 10.0)	N/A	
Change in walking for recreation Median (25th, 75th percentile) min/day	504	0.0 (-15.0, 7.1)	N/A	
Environmental attributes				
Area Socioeconomic Status (IER)	504		515	
% High (>1057.2)		33.3		28.7*
% Medium (936.6-1057.2)		33.1		32.0
% Low ($\leq$ 936.6)		33.5		39.2
Walkability Score (4-40), Mean (SD)	504	22.7 (7.9)	515	23.2 (7.8)

*p<0.05, **p<0.01 (those lost to follow-up versus participants)

BMI: body mass index, IER: index of economic resources

Table 2. Odds ratios, 95% confidence intervals (CI) for declines in walking for transport and walking for recreation, by demographic, behavioral, psychosocial and environmental attributes (final model, n=445 with complete data).

	n	Decline in walking for transport ^a			Decline in walking for recreation ^b		
		OR	(95% CI)	p ^c	OR	(95% CI)	p ^c
Demographics							
Age (years)	445	1.06	(0.95-1.19)	.264	1.01	(0.94-1.09)	.736
Gender							
men	202	1.00		.387	1.00		.110
women	243	0.66	(0.26-1.70)		1.75	(0.88-3.47)	
Behavioral attributes							
Walking for transport at baseline (min/day)	445	1.10	(1.07-1.13)	<.0001	1.01	(1.00-1.01)	.066
Walking for recreation at baseline (min/day)	445	1.00	(0.98-1.01)	.530	1.06	(1.05-1.07)	<.0001
Psychosocial attributes							
Self-efficacy for moderate PA							
High	189	1.00		.529	1.00		.001 ^d
Medium	125	1.24	(0.41-3.74)		2.05	(0.96-4.35)	
Low	131	1.47	(0.43-5.05)		0.25	(0.08-0.76)	*
Perceived benefits to regular PA							
High	129	1.00		.019	1.00		.172
Medium	166	0.36	(0.11-1.17)		1.80	(0.79-4.12)	
Low	150	0.17	(0.04-0.74)	*	1.92	(0.76-4.90)	
Social support for PA from family							
High	120	1.00		.024	1.00		.043
Medium	146	1.48	(0.41-5.32)		0.81	(0.36-1.84)	
Low	179	4.11	(1.11-15.19)	*	0.42	(0.18-0.98)	*
Social interaction							
High	149	1.00		.024 ^d	1.00		.729 ^d
Medium	140	0.18	(0.05-0.65)	**	0.73	(0.33-1.61)	
Low	156	0.94	(0.32-2.77)		0.87	(0.35-2.15)	
Sense of community							
High	139	1.00		.022	1.00		.544
Medium	167	0.40	(0.14-1.12)		1.11	(0.48-2.57)	
Low	139	0.22	(0.06-0.89)	*	1.34	(0.52-3.45)	
Environmental attributes							

Correlates of Change in Walking

Walking facilities							
High	142	1.00		.203 ^d	1.00		.080
Medium	153	0.35	(0.11-1.14)		2.56	(1.06-6.16)	*
Low	150	0.75	(0.21-2.71)		2.50	(0.90-6.98)	
Aesthetics							
High	123	1.00		.666	1.00		.207 ^d
Medium	206	1.27	(0.44-3.65)		0.48	(0.21-1.08)	
Low	116	1.32	(0.31-5.69)		0.61	(0.21-1.78)	
Walkability Score (4-40)	445	0.93	(0.88-0.99)	.027	1.00	(0.96-1.04)	.969

^a Decline = decreased more than 21.4 min/day (n=86 out of 445), bottom quartile of change

^b Decline = decreased more than 18.6 min/day (n=84 out of 445), bottom quartile of change

^c p for trend, unless otherwise noted

^d p reported is for chi-square test rather than trend, as association is not linear (and trend test is not statistically significant)

PA: physical activity

*p<0.05, **p<0.01 compared to the referent category.