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The potential for walkability to narrow neighbourhood socioeconomic inequalities in physical function: A case study of middle-aged to older adults in Brisbane, Australia

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ABSTRACT

Residents of disadvantaged neighbourhoods have poorer physical function than their advantaged counterparts, although the reasons for this remain largely unknown. We examined the moderating effects of walkability in the relationship between neighbourhood disadvantage and physical function using 2013 cross-sectional data from 5115 individuals aged 46–72 living in 200 neighbourhoods in Brisbane, Australia. The relationship between neighbourhood disadvantage and physical function differed by levels of walkability: positive associations as levels of walkability increased for those living in more disadvantaged neighbourhoods, and no difference for those living in more advantaged neighbourhoods. Further work is required to better understand the underlying mechanisms.

1. Introduction

Given the increasing ageing profile of the Australian population, an important health goal is to ensure healthy and active ageing (Australian Institute of Health and Welfare, 2017). Physical function, defined as the ability to undertake activities of daily living, is important for the maintenance of independence among older adults (Bohannon and DePasquale, 2009). Epidemiological studies show that middle-aged to older adults living in disadvantaged neighbourhoods have poorer physical function than their counterparts from more advantaged neighbourhoods (Feldman and Steptoe, 2004; Balfour and Kaplan, 2002; Wainwright and Surtees, 2004; Beard et al., 2009; Loh et al., 2016). Understanding the underlying mechanisms contributing to this relationship has been identified as a research priority (Kramer and Raskind, 2017; Cummins et al., 2007; Smith et al., 2017).

Recent studies and systematic reviews have shown that the neighbourhood built environment, and walkability in particular, are important in influencing the leisure-time and transport-related physical activities of younger- (18–65 years) (Christiansen et al., 2016) and older adults (≥65 years) (Van Cauwenberg et al., 2018; Barnett et al., 2017; Cerin et al., 2017). Walkability is typically characterised by street connectivity, density and land use mix (Saelens and Handy, 2008; Stevenson et al., 2016), or a composite measure that combines each of these built environment features. Street connectivity is the directness and availability of alternative routes from one point to another within a neighbourhood (Wilson et al., 2012). Dwelling density refers to the total number of dwellings per unit of land area, and land use mix describes the diversity of land uses (e.g. commercial, industrial, leisure/recreation, residential) within a neighbourhood (Wilson et al., 2012). Walkability and its components promotes physical activity for adults of all ages through (among other things) the provision of footpaths and bike lanes, access to local destinations (e.g., shops, public transport stops, health care centres) (Boakye-Dankwa et al., 2019), and a connected street network that reduces distance from place to place (Van Cauwenberg et al., 2018; Cerin et al., 2017). A study undertaken with middle-aged to older adults in Brisbane (Turrell et al., 2013) found that the built environments in socioeconomically disadvantaged neighbourhoods are characterised by greater street connectivity and a more diverse mix of land uses (i.e. were more walkable). As a consequence, the residents of these areas engaged in more transport walking than their counterparts from advantaged neighbourhoods.

To date, a small number of studies has examined the relationship

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between neighbourhood walkability (and its components) and physical function. Clarke and George (2005) found that neighbourhoods with limited land use mix were associated with poorer physical functioning among older adults. Freedman et al. (2008) found that street connectivity was associated with a reduced risk of limitations in instrumental activities of daily living among men aged 50 years and over. King et al. (2011) found that those with the lowest levels of physical function living in walkable neighbourhoods walked more than those with the highest levels of physical function living in less walkable neighbourhoods: this suggests that residing in a walkable neighbourhood supports people's ability to undertake everyday activities within neighbourhoods, even among those with lower levels of physical function.

In light of the existing evidence, walkability is likely to modify the relationship between neighbourhood disadvantage and physical function. The walkable built environments of disadvantaged neighbourhoods may support healthy behaviour such as physical activity and may potentially dampen what would otherwise be larger neighbourhood-based inequalities in physical function. It is therefore plausible that walkable disadvantaged neighbourhoods have a protective effect on the physical function of its residents; whereas low walkable disadvantaged neighbourhoods are likely to exacerbate neighbourhood inequalities in physical function.

The aim of this study is to examine whether the relationship between neighbourhood disadvantage and physical function differed by the level of neighbourhood walkability among middle-aged to older adults in Brisbane.

2. Methods

2.1. Study population

This investigation uses data from the HABITAT (**H**ow **A**reas in **B**risbane **I**nfluence Heal**T**h and **A**c**T**ivity) study. HABITAT is a multilevel longitudinal study of mid-aged adults living in the Brisbane Local Government Area, Australia (Turrell et al., 2010). The Brisbane Local Government Area has a medium density urban environment, with a population of 1.2 million in 2016 (Brisbane City Council, 2018), and is managed by a single city council (Sinnewe et al., 2016). The primary aim of HABITAT is to examine patterns of change in health and wellbeing over the period 2007–2016, and to assess the relative contributions of environmental, social, psychological and socio-demographic factors to these changes. The HABITAT study received ethical clearance from the Queensland University of Technology Human Research Ethics Committee (Ref. Nos. 3967H & 1300000161).

2.2. Sample

Details about HABITAT's baseline sampling have been published elsewhere (Burton et al., 2009). Briefly, a multi-stage probability sampling design was used to select a stratified random sample (n = 200) of Census Collector's Districts (CCD), and from within each CCD, a random sample of people aged 40–65 years (on average 85 per CCD). CCDs are embedded within a larger suburb, hence the area corresponding to, and immediately surrounding, a CCD is likely to have meaning and significance for their residents: for this reason, we hereafter use the term ‘neighbourhood’ to refer to each CCD. The baseline HABITAT sample (2007) was broadly representative of the wider Brisbane population (Turrell et al., 2010).

2.3. Data collection and response rates

A structured self-administered questionnaire was developed, and copies were sent to 17,000 potentially eligible participants in May 2007 using a mail survey method developed by Dillman (2000). After excluding out-of-scope respondents (i.e., deceased, no longer at the last known address and unable to participate for health-related reasons), 11,035 usable surveys were returned, yielding a baseline response rate of 68.3%. The corresponding response rates from in-scope and contactable participants in 2009, 2011, 2013 and 2016 were 72.6% (n = 7866), 67.3% (n = 6900), 67.1% (n = 6520), and 57.2% (n = 5188), respectively. This study used data collected for the 2013 survey (Wave 4) as physical function was first measured at this wave.

2.4. Neighbourhood-level measures

2.4.1. Neighbourhood socioeconomic disadvantage

Each of the 200 neighbourhoods was assigned a socioeconomic score using the ABS’ Index of Relative Socioeconomic Disadvantage (IRSD) (Australian Bureau of Statistics, 2013). A neighbourhood's IRSD score reflects each area's overall level of disadvantage measured on the basis of 17 variables that capture a wide range of socioeconomic attributes, including: education, occupation, income, unemployment, household structure, and household tenure (among others). The HABITAT neighbourhoods were grouped into quintiles based on their IRSD scores, with Q1 denoting the twenty-percent most advantaged areas relative to the whole of Brisbane, and Q5 the most disadvantaged twenty-percent.

2.4.2. Built environment measures

The neighbourhood-level data used to derive the objectively measured street connectivity, dwelling density and land use mix were provided by the Brisbane City Council (the local government authority responsible for the jurisdiction covered by the HABITAT study) and Pitney Bowes StreetPro (Tele Atlas, 2012).

2.4.3. Street connectivity

Calculated as a count of the number of four-way or more intersections within each neighbourhood. Greater connectivity indicates more choices en route and often a more direct travel route between origin and destination. The mean street connectivity was 2.9 (SD 2.4) four-way or more intersections per neighbourhood, ranging from 0 to 12.

2.4.4. Dwelling density

Calculated as the number of dwellings per hectare of residential land within each neighbourhood. Larger values represent greater density. For this analysis, dwelling density was divided by 100 so that the coefficient is interpreted as a 100-dwelling increase in density. The mean dwelling density was 17.8 (SD 7.5) (i.e., 1780 dwellings) per neighbourhood, ranging from 0.2 to 49.

2.4.5. Land use mix

Calculated using five classifications of land use: commercial, industrial, leisure/recreation, residential and other using the equation from Leslie et al. (2007), which results in a score ranging between 0 and 1. A score of 0 indicates that all land uses are of a single type and a score of 1 indicates that the area has an even distribution of land uses. A larger number represents a more heterogeneous distribution of land use. For this analysis, the land use variable was multiplied by 10 so that the coefficient is interpreted as a 0.1 (or 10%) increase in land use mix. The mean land use mix was 3.3 (SD 1.4) per neighbourhood, ranging from 0 to 7.5.

2.4.6. Walkability

Is a composite measure of street connectivity, dwelling density and land use mix. Each of these variables were standardized and summed to generate a walkability index. The mean walkability index was 0.003 (SD 1.81) per neighbourhood.

2.4.7. Neighbourhood self-selection

To assess residential preferences for living in a particular neighbourhood, participants were asked to respond on a five-item Likert scale (ranging from 'not at all important' to 'very important') to 14 statements asking 'How important were the following reasons for choosing your current address?' Examples of items included: 'Ease of walking to places', 'Closeness to schools', 'Closeness to open spaces (e.g., parks)' and 'Closeness to public transport'. Principal Components Analysis (PCA) with varimax rotation showed that 12 of the items loaded onto one factor, subsequently described as 'neighbourhood self-selection' (α = 0.84).

2.5. Individual-level measures, covariates and controls

2.5.1. Self-reported physical function

This was measured using the Physical Function Scale (PF-10), a component of the Short Form 36 Health Survey (Ware et al., 1994). The stem question of the PF-10 asked 'Does your health now limit you in these activities? If so, how much?'. Respondents were given the following choices as response for each activity: 'Yes, limited a lot' or 'Yes, limited a little' or 'No, not limited at all'. The PF-10 measures a hierarchical range of difficulties, from vigorous activities, such as lifting heavy objects to bathing and dressing (Haley et al., 1994). This measure has been extensively validated among community-dwelling adults using convergent validity calculated by Pearson Correlations using 3-performance based measures: single limb stance as an indicator of balance (r = 0.42), Time Up and Go test as a measure of mobility (r = −0.70) and gait speed as an indicator of overall functional capacity (r = 0.75) (Bohannon and DePasquale, 2009). The method of data cleaning for the physical function score was adapted from Ware et al. (1994). The raw physical function scores were calculated as the sum of re-coded scale items and was transformed to a 0–100 scale, where 0 represents minimal functioning, and 100 represents maximal functioning.

2.5.2. Education

Respondents were asked to provide information about the highest education qualification completed. Respondents were coded as Bachelor degree or higher (the latter included postgraduate diploma, master's degree, or doctorate), Diploma (associate or undergraduate), Vocational (trade or business certificate or apprenticeship), and No post-secondary school qualification.

2.5.3. Occupation

Respondents who were employed at the time of completing the survey were asked to indicate their job title and then to describe the main tasks or duties they performed. This information was coded to the Australian and New Zealand Standard Classification of Occupations (ANZSCO). For the purpose of this study, the original ANZSCO classification was recoded into three categories: Managers/professionals, White-collar employees, and Blue-collar employees. Respondents who were not employed were categorised as follows: Home duties, Retired, Permanently unable to work.

2.5.4. Household income

Respondents were asked to indicate their total annual household income (including pensions, allowances and investments) using a 14-category measure that was subsequently recoded into six groups for analysis: AU$130,000 or more, AU$78,800-129,999, AU$52,000-72,799, AU$26,000-51,999, Less than AU$25,999, and Not classified (i.e., ticked 'Don't know' or 'Don't want to answer this', or left the income question blank).

2.5.5. Distance from Central District Business (CBD)

This measure was used in some modelling to adjust for spatial confounding (see Statistical analysis). Distance from the CBD was obtained from the Geographical Information Systems (GIS) data by measuring the straight line distance (km) between the CBD and each respondent's dwelling.

2.5.6. Age and gender

Respondents self-reported their date of birth and gender in the survey. The mean age for this sample was 58 years (ranged between 45 and 74 years). The age variable was categorised into 5 groups: 45–49 years, 50–54 years, 55–59 years 60–65 years and 66 years and older. The proportion of men and women in this sample was 42% and 58%, respectively.

2.6. Statistical analysis

These cross-sectional analyses used data from the 2013 HABITAT survey. We excluded respondents who had moved since 2007 (n = 1153), as relocating to a different neighbourhood may have been be influenced by unmeasured preferences related to both residential choice and physical function (Hirsch et al., 2014). Hence, 200 neighbourhoods were included in the analyses. Participants with missing data for physical function (n = 82), education (n = 14) and neighbourhood self-selection (n = 156) were also excluded. This reduced the analytic sample to 5115. Sensitivity analyses (not presented here) revealed that those excluded due to missing data did not significantly differ from included participants on neighbourhood disadvantage, education and physical function.

The analyses were conducted in three stages. First, the relationship between neighbourhood disadvantage and physical function was examined using multilevel linear regression (MLLR), and the data were graphically presented as mean differences in function between the neighbourhood quintiles, adjusted for age, individual-level socioeconomic position (SEP) (i.e., education, occupation, and household income) and neighbourhood self-selection. Second, the moderating effects of walkability and its components on the association between neighbourhood disadvantage and physical function were estimated by adding two-way interaction terms on the main effects for the walkability and its components separately. As recommended by Lamb and White (2015), walkability and its components were entered into the analytic models as continuous variables to avoid loss of information and allow comparisons between studies. Results for this step were presented graphically, with predicted physical function score (0–100 scale) plotted against walkability variables. All data were prepared in Stata SE 15 (Stata Statistical Software: Release 13, 2013) and the analyses were conducted using MLwiN version 3.01 (MLwiN Version 2.3 [computer program], 2009).

3. Results

Sociodemographic characteristics and mean physical function score of the study sample are shown in Table 1. Mean physical function scores were lowest among residents of the most disadvantaged neighbourhoods, those in the oldest age group, women, the least educated, those who were permanently unable to work, and members of lower income households.

3.1. Neighbourhood disadvantage and physical function

There was a strong, graded association between neighbourhood disadvantage and physical function (Fig. 1). After adjustment for age and potential confounders, residents living in the most disadvantaged neighbourhoods reported significantly poorer physical function than their counterparts living in the most advantaged neighbourhoods.

The results for the main effect and moderation analysis are presented in Table 2, and the predicted means from these models are presented in Fig. 2A–D. Likelihood ratio tests revealed that the models for land use mix and walkability have a better fit than the models without the interaction term (data not shown). The relationship between neighbourhood disadvantage and physical function was significantly moderated by dwelling density (Fig. 2B), land use mix (Fig. 2C), and walkability (Fig. 2D). The differences in physical function

Table 1
Sociodemographic characteristics and mean (95% confidence interval) physical function scores for the HABITAT analytic sample in 2013.

Sociodemographic characteristics	**Physical function**[a]	
N = 5115	**(%)**	**Mean (95% CI)**
Neighbourhood disadvantage		
Q1 (least disadvantaged)	20.9	89.5 (88.6, 90.4)
Q2	27.3	87.6 (86.7, 88.5)
Q3	19.7	84.9 (83.8, 86.1)
Q4	18.7	82.3 (81.4, 83.9)
Q5 (most disadvantaged)	13.2	77.3 (75.4, 79.2)
Age		
45–49 years	19.9	90.6 (89.7, 91.6)
50–54 years	21.9	87.5 (86.5, 88.6)
55–59 years	20.4	85.6 (84.5, 86.7)
60–65 years	20.1	82.7 (81.4, 83.9)
66+ years	17.7	78.5 (77.0, 80.0)
Sex		
Men	42.4	87.7 (86.9, 88.4)
Women	57.6	83.3 (82.6, 84.0)
Education		
Bachelor degree or higher	35.2	88.6 (87.8, 89.3)
Diploma/associate degree	11.9	86.3 (84.9, 87.7)
Certificate	16.8	85.0 (83.7, 86.3)
No post-school qualification	36.1	81.5 (80.5, 82.5)
Occupation		
Professional	32.5	90.4 (89.7, 91.1)
White collar	19.9	87.6 (86.6, 88.6)
Blue collar	10.7	87.7 (86.2, 89.1)
Home duties	5.2	83.6 (81.2, 86.0)
Retired	22.0	78.8 (77.5, 80.1)
Permanently unable to work	2.0	46.0 (40.2, 51.8)
Not easily classifiable[b]	7.7	82.4 (80.7, 84.8)
Income		
$130,000+	20.6	91.7 (91.0, 92.5)
$72,800–129,999	23.8	87.9 (87.0, 88.8)
$52,000–72,799	12.3	85.5 (84.1, 86.9)
$26,000–51,999	18.5	80.7 (79.4, 82.0)
Less than $25,999	10.1	73.5 (71.5, 75.7)
Not classified[c]	14.7	84.8 (83.3, 86.3)

[a] Physical function score ranged from 0 to 100, where 0 represents minimal functioning and 100 represents maximal functioning.

[b] Not easily classifiable: students, unemployed or other classifiable.

[c] Not classified: those who reported ‘Don’t know’ or ‘Don’t want to answer this’, or left the income question blank.

scores were largest among those living in lower levels of density, land use mix and walkability and smallest among those living in higher levels of density land use mix and walkability across quintiles of neighbourhood disadvantage. Among those living in the more advantaged neighbourhoods (Q1–Q3), physical function was similar across levels of walkability and its components (indicated by the flat and slightly negative slopes). By contrast, among those living in the most disadvantaged neighbourhoods (Q5), positive associations were observed: as the levels of dwelling density, land use mix, and walkability increased, so did physical function scores.

4. Discussion

This study examined whether the relationship between neighbourhood disadvantage and physical function differed by level of walkability. Consistent with previous research (Feldman and Steptoe, 2004; Wainwright and Surtees, 2004; Beard et al., 2009), we found that living in more disadvantaged neighbourhoods was associated with poorer physical function among middle-aged to older participants after adjusting for individual-level SEP and neighbourhood self-selection. Further, the association between neighbourhood disadvantage and physical function was heterogeneous across levels of dwelling density, land use mix and walkability.

As dwelling density, land use mix, and walkability increased, physical function increased for those living in the most disadvantaged neighbourhood compared to those living in the more advantaged neighbourhoods. This finding supported our hypothesis that higher levels of walkability in disadvantaged neighbourhoods may serve to narrow neighbourhood inequalities in physical function among middle-aged to older adults. A number of possible mechanisms may explain the significant associations found in our study. First, residents of more disadvantaged neighbourhoods may be more sensitive to the design and/or the resources within their neighbourhood than residents of more advantaged neighbourhoods. Studies have shown that residents living in more disadvantaged neighbourhoods are less likely to own a car (Turrell et al., 2013) and therefore, the resources available within their immediate neighbourhood may become more important for meeting daily needs (Danielewicz et al., 2017). Neighbourhoods that are walkable and dense are indicative of greater access to a variety of destinations. Hence, the second possible mechanism could be that these destinations (e.g. access to health and social services, supermarkets, and employment opportunities) may assist residents living in disadvantaged neighbourhoods to maintain and manage their health (Badland et al., 2014). Third, in the presence of a walkable built environment, residents of disadvantaged neighbourhoods are more likely to walk or cycle for transport (Kerr et al., 2015; Saelens et al., 2003). Walking, for example,

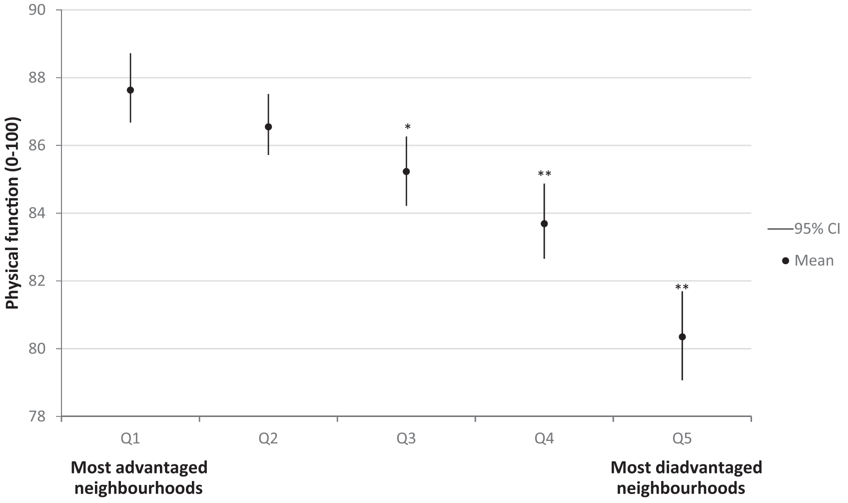

Fig. 1. Relationship between neighbourhood disadvantage and physical function (0–100). Model adjusted for within neighbourhood variation in age, education, occupation, household income and neighbourhood self-selection. * $p < 0.01$; ** $p < 0.001$.

Table 2
Association between neighbourhood disadvantage and physical function by level of walkability (and its components).

	Physical function β (95%CI)	
	Model 1[a]	**Model 2**[b]
Neighbourhood disadvantage		
Q1 (most advantaged) [ref]	–	
Q2	−1.06 (−2.55, 0.42)	
Q3	−2.42 (−4.05, −0.81)**	
Q4	−4.00 (−5.66, −2.33)***	
Q5 (most disadvantaged)	−7.34 (−9.17, −5.52)***	
Interactions		
Neighbourhood disadvantage × Street connectivity[c]		
Q1 × Street connectivity (ref)		–
Q2 × Street connectivity		0.07 (−0.18, 0.34)
Q3 × Street connectivity		0.11 (−0.15, 0.38)
Q4 × Street connectivity		0.23 (−0.05, 0.51)
Q5 × Street connectivity		0.10 (−0.24, 0.44)
Neighbourhood disadvantage × Dwelling density[d]		
Q1 × Dwelling density (ref)		–
Q2 × Dwelling density		0.03 (−0.19, 0.26)
Q3 × Dwelling density		0.14 (−0.08, 0.37)
Q4 × Dwelling density		0.09 (−0.18, 0.37)
Q5 × Dwelling density		0.31 (0.05, 0.55)*
Neighbourhood disadvantage × Land use mix[e]		
Q1 × Land use mix (ref)		–
Q2 × Land use mix		−0.43 (−1.47, 0.60)
Q3 × Land use mix		0.12 (−1.02, 1.27)
Q4 ×Land use mix		0.42 (−0.67, 1.53)
Q5 × Land use mix		1.50 (0.31, 2.68)*
Neighbourhood disadvantage × Walkability[f]		
Q1 × Walkability (ref)		–
Q2 × Walkability		0.14 (−0.72, 1.01)
Q3 × Walkability		0.68 (−0.32, 1.68)
Q4 × Walkability		1.13 (0.15, 2.11)*
Q5 × Walkability		2.06 (0.97, 3.14)**

Abbreviations: CI, confidence intervals.

[a] Model 1 adjusted for age, sex, education occupation, household income and neighbourhood self-selection.

[b] Model 2: Model 1 plus adjustment for street connectivity, dwelling density, land use mix and walkability in each interaction model, respectively.

[c] Street connectivity ranged from 0 to 12.

[d] Dwelling density ranged from 0.2 to 49.

[e] Land use mix ranged from 0 to 7.5.

[f] Walkability is the standardised sum of street connectivity, dwelling density and land use mix.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

is a common and cost-effective physical activity for disadvantaged and less physically active populations (women, older adults, those of low socioeconomic status, and those living in more disadvantaged areas) (Benach et al., 2013; Gordon-Larsen et al., 2006; Hutch et al., 2011). Our Brisbane findings could empower policy makers from other jurisdictions to reduce health inequities between advantaged and disadvantaged neighbourhoods by developing environments that are more supportive for walking.

4.1. Limitations

Several methodological and analytic issues need to be considered when interpreting this study's results. First, the cross-sectional nature of this analysis means that claims about causality are limited. However, this study adjusted for residential self-selection into neighbourhoods. A recent systematic review of the associations between neighbourhood built environment and physical activity revealed that failing to include residential self-selection limits the inference that can be made from cross-sectional studies (McCormack and Shiell, 2011). Second, the study data were obtained from the fourth wave (2013) of the HABITAT study. The non-response and sample attrition from baseline to the fourth wave may have implications for generalisability. Third, even though the self-reported physical function items are well validated (Bohannon and DePasquale, 2010; McHorney et al., 1993), they are susceptible to recall and/or desirability bias and are unable to discriminate high functioning adults (e.g., those who self-reported 'No, not limited at all' in most activities). By contrast, performance-based measure of physical function better capture differences among high-functioning individuals, but perform poorly at discerning those with lower levels of functioning. Future studies should incorporate both self-reported and performance-based measure of physical function to comprehensively understand the complexity of physical function among middle-aged to older adults. Fourth, the neighbourhood walkability measures used in this study did not capture the quality of neighbourhood built environment features. A US study suggested that the benefits of macroscale built environment features that are conducive to transport walking may not be realised in the presence of a poor quality pedestrian features (such as the uneven or cracked footpaths) (Thornton et al., 2016). Also, for the walkability index, including retail floor area would have added strength to the study as it increases sensitivity to retail use relevant to pedestrian activity (Frank et al., 2009). Fifth, this study used a generic land use mix measure that combined commercial, recreational, industrial, residential and other land uses. A measure such as this is unable to identify the actual destinations available within the neighbourhoods. For instance, two neighbourhoods with the same land use score may have very different destinations within the neighbourhoods that could be positively or negatively associated with physical function. Finally, the generalisability of this study's findings will likely depend on a city's similarities to Brisbane, both in geographical area and population distribution, and specifically, the spatial patterning of socioeconomic disadvantage.

To our knowledge, no prior published study has examined the effect modification of neighbourhood walkability in the relationship between neighbourhood disadvantage and physical function. Our findings revealed that walkability moderated the relationship between neighbourhood disadvantage and physical function: the physical function score differences are smallest at higher levels of walkability and greatest at lower levels of walkability across quintiles of neighbourhood disadvantage. These findings are important as they can effectively guide research translation for public health interventions. The World Health Organization (2015) for example, has recently disseminated a report on ageing and health to promote neighbourhood design that support 'ageing in place' through reducing built environment barriers to facilitate mobility and independence among the ageing population. Since neighbourhood walkability has been positively associated with access to education, employment, health care services, shops and services, all of which are important to health (Badland et al., 2014), policy-makers should focus on improving walkability in all neighbourhoods to reduce social inequalities in health.

5. Conclusion

The mechanisms linking neighbourhood disadvantage and physical function are complex. At least in Brisbane, walkability has the potential to narrow neighbourhood inequalities in physical function. Other factors not considered in the study may have further attributed to the differences in physical function between advantaged and disadvantaged neighbourhoods: further research is required to identify these factors.

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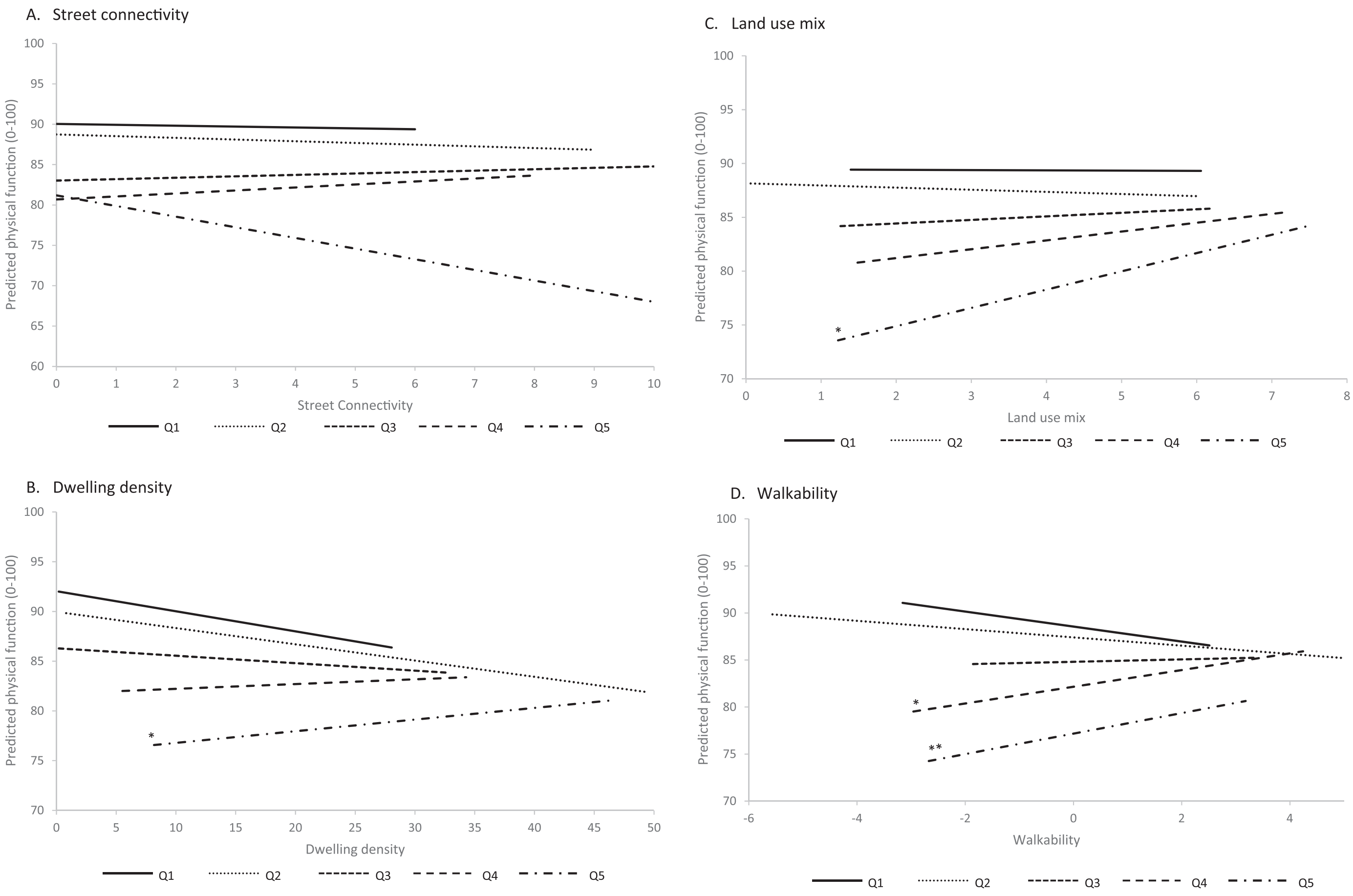

Fig. 2. The relationship between neighbourhood disadvantage and physical function by the levels of – A. street connectivity, B. dwelling density, C. land use mix and D. walkability. Q1 represents most advantage neighbourhoods and Q5 represents most disadvantaged neighbourhoods. * $p < 0.05$; ** $p < 0.001$.

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Conflict of interest/Financial disclosure

The authors declare they have no actual or potential competing financial interests.

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