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Associations of public transport accessibility with walking, obesity, metabolic syndrome and diabetes

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ABSTRACT

Objective: To examine associations of public transport system accessibility with walking, obesity, metabolic syndrome and diabetes/impaired glucose regulation.
Methods: Associations of public transport accessibility with self-reported walking for transport or recreation and measured biomarkers of chronic disease risk were estimated in 5241 adult residents of 42 randomly selected areas in Australia in 2004/05, drawn from the second wave of a population-based cohort study (AusDiab). Public transport accessibility was objectively measured using an adaptation of the Public Transport Accessibility Levels (PTAL) methodology, comprising both GIS derived spatial and temporal accessibility measures. Logistic regression models were adjusted for individual and environmental level covariates and clustering within areas.
Results: Above median public transport accessibility was positively associated with a walking time of more than the median 90 min per week (OR=1.28, 95%CI 1.03, 1.60) and walking above the recommended 150 min per week (OR=1.35, 95%CI 1.11, 1.63). There were no associations of public transport accessibility with obesity (OR=1.05, 95%CI 0.85, 1.30), the metabolic syndrome (OR=1.09, 95%CI 0.91, 1.31) nor diabetes/impaired glucose regulation (OR=1.11, 95%CI 0.94, 1.30). Findings were similar for a subgroup reporting no vigorous recreational physical activity.
Conclusions: In this Australian sample, public transport accessibility was positively associated with walking at recommended levels, including for people who are not otherwise vigorously active.
Significance: Walking is crucial for increasing physical activity levels and population health, as well as maximising public transport system efficiency. Building evidence on public transport accessibility and walking will enable governments to exploit this important synergy.

1. Introduction

Innovations in technology designed to increase quality of life and economic productivity have resulted in shifts in our lifestyles and behaviours with, potentially, unexpected impacts on population health. Transportation technology is a case in point: our reliance on motorised transport has seen cars increasingly replace the vehicle of the human body in facilitating human movement, and fossil fuels progressively subsume the role of food in energizing it (Woodcock et al., 2007). There is increasing evidence that the population wide reduction in physical activity associated with transportation, communication and other technological advances poses a significant and growing health problem. Undertaking sufficient physical activity can significantly reduce disease risk, including all-cause mortality, cardiovascular disease and diabetes (Warburton et al., 2010). However physical activity participation rates in Australia and internationally are low and show little evidence of improvement: only 43% of Australian adults met physical activity guidelines in 2011–12 (Australian Bureau of Statistics, 2015). In addition, chronic conditions related to physical inactivity are increasing, with an estimated prevalence of obesity at

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27%, metabolic syndrome at 16 to 29% and diabetes at 4.5% of Australian adults (Tanamas et al., 2013; Australian Bureau of Statistics, 2015; AIHW Australian GP Statistics and Classification Centre, 2006; Zimmet et al., 2005).

Increasing the number of trips undertaken by active travel modes such as walking and cycling is one way to increase physical activity and reduce the burden of chronic disease, as well as a means to reduce the environmental burden of private automobile use. Walking is the most frequently reported form of physical activity for Australian adults (Australian Bureau of Statistics, 2015). Walking to public transport is the most frequently reported purpose for walking trips from home in Australian household travel surveys (Burke and Brown, 2007; Corpuz et al., 2005).

Public transport accessibility and use have become the focus of an increasing number of studies examining environmental and individual level factors influencing walking. Public transport accessibility is a necessary, but not sufficient, precursor of public transport use, with travel behaviour influenced by a range of other factors including individual attributes, socioeconomic status and vehicle ownership (Zwald et al., 2014; Corpuz, 2007; Laverty et al., 2013).

Evidence on the association of public transport use and walking is clear: studies have generally found public transport use or commuting is positively associated with walking (Rissel et al., 2012; Moudon et al., 2007; Lachapelle and Noland, 2012; Lachapelle and Frank, 2009; Edwards, 2008; Wener and Evans, 2007; Beavis and Moodie, 2014; Saelens et al., 2014) and physical activity; (Saelens et al., 2014; Brown and Werner, 2007) with Australian and North American studies finding public transport users and commuters had a two to eight times higher odds of meeting physical activity recommendations, dependent on frequency of use (Zwald et al., 2014; Moudon et al., 2007; Lachapelle and Frank, 2009; Wener and Evans, 2007; Lachapelle et al., 2011; Villanueva et al., 2008).

The results of studies using objective measures of spatial accessibility of public transport stops in residential neighbourhoods (i.e. having closer or more numerous stops) are more equivocal. Some found increased accessibility to be associated with higher levels and/or frequency of walking (McConville et al., 2011; Hoehner et al., 2005; McCormack et al., 2008; Targa and Clifton, 2005; Coogan et al., 2009) and meeting physical activity recommendations, (Djurhuus et al., 2014a) while others reported no association (Pikora et al., 2006; Boarnet et al., 2008) or mixed findings by stop distance (Lachapelle and Frank, 2009) or walking outcome(Wilson et al., 2012). One cross-national study found positive associations of perceived public transport accessibility with meeting physical activity recommendations in only three of the eleven countries studied (Ding et al., 2013).

Evidence of the association of public transport accessibility and obesity follows a similar mixed pattern, with some studies finding that public transport use (Webb et al., 2012) and commuting (Laverty et al., 2013; MacDonald et al., 2010; Flint et al., 2014) were negatively associated with BMI, overweight or obesity, and other studies finding no evidence of an association between access (Boehmer et al., 2007) or use (Millett et al., 2013) and overweight/obesity, or mixed findings by mode (Rundle et al., 2007), gender (Wen and Rissel, 2008; Lindström, 2008) or socioeconomic status (Lovasi et al., 2009). To our knowledge there is no other published research on the association of public transport accessibility and metabolic syndrome. However studies of commuting suggest reduced risk of metabolic syndrome or its components with increased time of active commuting (von Huth Smith et al., 2007; Gordon-Larsen et al., 2009; Kwaśniewska et al., 2010) and reduced commuting distance (Hoehner et al., 2012). Two studies found no evidence of an association between diabetes risk and commuting by public transport, relative to commuting by car (Laverty et al., 2013; Millett et al., 2013).

Some of the ambiguity in the evidence on public transport accessibility may relate to the fact that with some exceptions (Djurhuus et al., 2014a, b; Kamada et al., 2009; Wasfi et al., 2013) studies have relied on spatial measures such as distance to, or density of, public transport stops. These do not measure other aspects of public transport accessibility which determine use and walking, including the frequency of services and the speed and ease with which destinations can be reached by public transport relative to car. Close stop spacing and high density of stops may in fact be indicators of poor public transport system accessibility, if they reflect meandering 'milk run' type routes with low service frequencies and long travel times, typical of bus routes in the outer suburbs of Australian cities (Public Transport Users Association, 2012). Studies that did incorporate temporal and other service measures, demonstrate increases in walking with increased service frequency (Djurhuus et al., 2014a, 2014b; Wasfi et al., 2013). One study showed stronger associations of meeting physical activity recommendations with service frequency at higher serviced stops and travel time contours from all walkable stops, compared to equivalent measures from the nearest stop (Djurhuus et al., 2014a, 2014b). This reinforces the need to measure all opportunities for public transport within walking distance. Spatial and temporal measures are sometimes assessed independently of each other, for different modes, in separate regression models, (Djurhuus et al., 2014) providing detailed measurement but raising questions of how these accessibility dimensions interact.

This study examined if access to public transport, assessed by an integral measure incorporating stop distance, service frequency, number of routes and mode mix, was associated with walking for transport or recreation and obesity, metabolic syndrome and diabetes/impaired glucose regulation in Australian adults (28 to 93 years). In addition, it investigated whether these associations were evident for a sub group of people who do not otherwise engage in vigorous recreational physical activity and are most likely to benefit from public transport related walking.

2. Materials and methods

2.1. Study population

The study included participants from the second wave (2004–05) of the *Australian Diabetes, Obesity and Lifestyle (AusDiab) Study;* a longitudinal, national, population-based study investigating diabetes, heart and kidney disease (Barr et al., 2006). The study methods have been documented elsewhere (Dunstan et al., 2001; Dunstan et al., 2002). In summary, baseline data were collected in 1999. Six census collection districts (CDs) were randomly selected in each of the six states and the Northern Territory and supplemented with contiguous CDs to achieve a minimum expected collection district cluster (CDC) sample size of 250 participants in each cluster (Dunstan et al., 2001, 2002). Twenty nine of the 42 CDCs were in state capitals and 13 in regional cities and rural towns.

Adults over 25 years resident in households in the 42 CDCs were invited to participate in the research (Dunstan et al., 2001). In wave 1, 20,257 adults were interviewed and 11,247 (55.3%) also underwent a physical examination and answered interviewer-administered questionnaires (Dunstan et al., 2001).