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Modest ratios of fast food outlets to supermarkets and green grocers are associated with higher body mass index: Longitudinal analysis of a sample of 15,229 Australians aged 45 years and older in the Australian National Liveability Study

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ABSTRACT

Food purchasing decisions are made within the context of the range of options available, yet most epidemiological studies focus upon single outlet types. Ratios of fast food outlets to supermarkets and green grocers were linked to addresses of 15,229 adults in the 45 and Up Study at baseline (2006–2008) and follow-up (2009–2010). Compared to having no fast food outlet but having healthy food outlets within 3.2 km from home, multilevel growth curves revealed that relative exposure > 25% fast food outlets were associated with 0.36–1.19 kg/m^2 higher BMI ($p < 0.05$). These associations were consistent as people aged. No associations were observed for food outlets < 0.8 km.

1. Introduction

Urbanization, economic growth and population ageing are widely attributed as drivers of spatial inequities in obesity and cardiometabolic diseases like type 2 diabetes mellitus. These health conditions can result in many unfavourable social and economic penalties, including billions in health service costs (Colagiuri et al., 2010). Traditionally, health sector prevention efforts have focussed upon weight loss management via lifestyle-focussed interventions (Tuomilehto et al., 2001). However, these interventions tend to be difficult to upscale into population-level prevention strategies (Leeder and Downs, 2014). This lack of success has driven the use of other health sector-based interventions for achieving weight loss such as pharmacotherapy and bariatric surgery. While these interventions can reduce disease risk at the individual level (Colagiuri, 2014), they do not change the underlying circumstances that increase the risk of disease occurring in the first place. Material deprivation, psychosocial stressors, poor access to healthy food and safe drinking water, air pollution, violence, isolation and other socio-environmental risk factors that conspire to insult, wear down and leave many communities vulnerable to preventable diseases, avoidable hospitalisations and premature mortality; these are the 'social determinants of health' (Wilkinson and Marmot, 2003).

Health policy decision-makers and advocates are increasingly aware of the need for coordinated multi-sectoral preventive action to promote health across the lifecourse. For example, recent residential and national initiatives in the United States and elsewhere to identify and intervene in so-called "food deserts" (New York City Industrial Development Agency, 2011; Office of the First Lady, 2010) in disadvantaged areas highlight the importance of the residential food environment as a social determinant of obesity and cardiometabolic disease. The residential food environment is, broadly for the purposes of definition in this study, the availability of food outlets near where a person lives. In prior research, the residential environment is usually considered to be anything from 0.4 km (km, or 0.25 miles) up to 3.2 km (2 miles), or approximately 5–30 min of brisk walking (Christian et al., 2011). An 0.8 km (0.5 mile) buffer is often used by urban planners (Agrawal et al., 2008; Cervero, 2006) and 1.6 km (1 mile) has been recommended by the US Surgeon General (National Prevention Council, 2014). Food deserts are considered a special case of residential food environment characterisation, defined in the United States Food, Conservation, and Energy Act of 2008 (the '2008 Farm Bill') as an "area with limited access to affordable and nutritious food,

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particularly such an area composed of predominantly lower income neighbourhoods *[sic]* and communities" (Title VI, Sec. 7527) (United States Department of Agriculture, 2009). Many policy-makers are of the belief that living in a "food desert" or other potentially unfavourable residential food environments in cities, such as a neighbourhood where fast food outlets concentrate, increases the risk of developing obesity through encouraging unhealthy food choices (Cavill and Rutter, 2013; Jones et al., 2007).

Consistent with the 1986 World Health Organization's Ottawa Charter, efforts are underway to create supportive residential food environments that encourage healthier food shopping patterns (Cavill and Rutter, 2013). In the US, this has sometimes meant the opening of 'green carts' and new supermarkets in food deserts where there previously was little or no healthier food options available. However, the evidence from reviews (Lovasi et al., 2009; Feng et al., 2010; Giskes et al., 2007; Holsten, 2009; Gordon-Larsen et al., 2006) and pre-post studies (Cummins et al., 2005, 2014; Wrigley et al., 2003; Ghosh-Dastidar et al., 2017; Zhang et al., 2016, 2017; Dubowitz et al., 2015a, 2015b) to support these interventions is equivocal. Fast food availability is hypothesised to increase the odds of selecting unhealthy, high salt, high sugar food with low nutrition content, but findings are mixed (Fleischhacker et al., 2011; Fraser et al., 2010). Some studies indicate poorer diet and higher weight status with greater fast food outlets availability (Boone-Heinonen et al., 2011; Bodor et al., 2010; Mehta and Chang, 2008; Spence et al., 2009; Li et al., 2009; Currie et al., 2009), but not all (Morland et al., 2002; Jago et al., 2007; Richardson et al., 2011; Lopez, 2007; Wang et al., 2007; Sturm and Datar, 2005; Burdette and Whitaker, 2004; Simmons et al., 2005; Jeffery et al., 2006). Conversely, other studies report better health (Morland et al., 2002; Laraia et al., 2004; Rose and Richards, 2004; Moore et al., 2008) and lower weight status (Bodor et al., 2010; Lopez, 2007; Wang et al., 2007; Morland et al., 2006; Powell et al., 2007a) among participants living closer to a supermarket, but many do not (Boone-Heinonen et al., 2011; Jago et al., 2007; Wang et al., 2007; Ford and Dzewaltowski, 2010; Jilcott et al., 2011; Gary-Webb et al., 2010; Casagrande et al., 2011). Related research on the health impacts of proximity to smaller supermarkets (i.e. grocery and convenience stores) finds both positive (Bodor et al., 2010; Morland et al., 2006; Powell et al., 2007a) and null or negative findings (Jago et al., 2007; Sturm and Datar, 2005; Morland et al., 2006; Inagami et al., 2006).

Heterogeneity in research designs, data collection and analytical techniques may explain some of the mixed findings. Some have also suggested that local contextual factors may modify the direction of association between food environment indicators and health variables (Chi et al., 2013), which may help to explain why some studies find that the risk of becoming overweight and obese among women may be influenced by area-level socioeconomic circumstances far more so than men (Feng and Wilson, 2015a, 2015b). Among many drawbacks of the literature thus far, two are important to highlight. First is the reliance on single-attributes of residential food environment, such as proximity to the nearest supermarket or the density of fast food outlets (Morland et al., 2006; Rundle et al., 2009). Since shopping and purchasing decisions are likely to be made based upon the market of food outlets that are available within a particular distance of travel, this approach appears suboptimal. Ratios of healthy to unhealthy food outlets (Mehta and Chang, 2008; Spence et al., 2009; Powell et al., 2007b; Polsky et al., 2016; Mason et al., 2013; Clary et al., 2015) and other multi-attribute approaches (Gordon et al., 2011; Minaker et al., 2013) for exposure definition are comparatively rare in this literature and warrant further investigation (Lytle and Sokol, 2017).

The second drawback is that the focus of epidemiological studies on residential food environment has tended to be on paediatric or general adult populations, yet the vast burden of obesity, cardiometabolic diseases and related hospital costs affect adults of middle-to-older age who may also interact with residential food environments differently. A reasonably intuitive example is that food environment close to home may be especially important to people with restricted spatial mobility due to functional limitations, which are increasingly common with age. Less intuitive, perhaps, are the reported gender differences in the magnitude of overweight and obesity risk between affluent and disadvantaged areas (Feng and Wilson, 2015a, 2015b). Stafford et al. (2005) suggested three possible (and inter-related) explanations for gender differentials in environmental effects on health. First, gender differences in neighbourhood perceptions (e.g. safety) may stimulate gender differences in psychosocial stress and related behaviours (e.g. diet and physical activity). Second, gender differences in other factors, such as employment type, may contribute to gender differences in the duration of exposure to neighbourhood characteristics (Kwan, 2000). Third, differences in social roles between men and women may also lead to gender differences in the intensity of exposure to some environmental factors. For example, women in some contexts may be more likely to be responsible for child-rearing than men (Craig et al., 2015), which could lead to greater involvement in other activities that take place in the local area, such as social networks that operate through schools and community groups, which could act as conduits for the spread of behaviours that influence weight status (Christakis and Fowler, 2007)). In short, residential food environment may contribute to gender differences in the socioeconomic patterning of overweight and obesity.

Accordingly, the aims of this study were: (i) to assess associations between the body mass index (BMI) among city-based adults in middle-to-older age with measures of residential food environment; (ii) to contrast findings from univariate and ratio-based approaches to measuring residential food environment; and (iii) to examine the extent that residential food environment helps to explain the gendered patterning of BMI with respect to area-level socioeconomic circumstances. We hypothesised that higher BMI would be observed among people living in areas where there were higher counts and concentrations of fast food outlets relative to vendors offering healthier options. We further hypothesised that the associations between residential food environment and BMI would be stronger among women and, therefore, help to explain the more substantive patterning of BMI across neighbourhood socioeconomic circumstances observed for women relative to men (Feng and Wilson, 2015a, 2015b).

2. Method

2.1. Population sample

This study was set in Australia. Baseline data were extracted from the Sax Institute's 45 and Up Study (collected between 2006 and 2009) and follow-up data of the same participants from the Social Economic and Environmental Factors Study (SEEF) (collected between 2009 and 2010). Ethical approval for the 45 and Up Study was granted by the University of New South Wales Human Research Ethics Committee (HREC 05035/HREC 10186). Ethical approval for the Social Economic and Environmental Factors Study by the University of Sydney Human Research Ethics Committee (ref no. 10-2009/12187). Ethical approval for this study was granted by the University of Wollongong HREC (HE16/158).

Participants in the 45 and Up Study were randomly sampled from the Department of Human Services (formerly Medicare Australia) enrolment database, which provides near complete coverage of the population. A total of 267,153 responses to the self-complete questionnaire were received between 2006 and 2009, with a response rate of approximately 18% (nearly 1 in every 10 people aged 45 years or older living in the Australian state of New South Wales) (45 and Up Study Collaborators, 2008). Participants were aged 45–106 years old (mean = 62). The first 100,000 baseline respondents (recruited between 2006 and 2008) were invited to participate in the Social Economic and Environmental Factors Study in 2010, replicating many of the questions asked at baseline, affording longitudinal analyses. A