



Is neighbourhood obesogenicity associated with body mass index in women? Application of an obesogenicity index in socioeconomically disadvantaged neighbourhoods

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ARTICLE INFO

Article history:

Received 10 March 2014

Received in revised form

30 June 2014

Accepted 27 July 2014

Available online 23 August 2014

Keywords:

Food environment

Neighbourhoods

Obesity

Obesogenicity index

Physical activity environment

ABSTRACT

An aggregate index is potentially useful to represent neighbourhood obesogenicity. We created a conceptually-based obesogenicity index and examined its association with body mass index (BMI) among 3786 women (age 18–45 y) in socio-economically disadvantaged neighbourhoods in Victoria, Australia. The index included 3 items from each of 3 domains: food resources (supermarkets, green grocers, fast food restaurants), recreational activity resources (gyms, pools, park space), and walkability (4+ leg intersections, neighbourhood walking environment, neighbourhood safety), with a possible range from 0 to 18 reflecting 0–2 for each of the 9 items. Using generalised estimating equations, neighbourhood obesogenicity was not associated with BMI in the overall sample. However, stratified analyses revealed generally positive associations with BMI in urban areas and inverse associations in rural areas (interaction $p=0.02$). These analyses are a first step towards combining neighbourhood characteristics into an aggregate obesogenicity index that is transparent enough to be adopted elsewhere and to allow examination of the relevance of its specific components in different settings.

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1. Introduction

In the last thirty years, the obesity rate has increased rapidly across the globe, particularly in high income countries. In Australia, for example, obesity rates are currently at 25%, with an estimated third of the population expected to be obese by 2020 (Australian Bureau of Statistics, 2012). The rise in obesity in high income countries has been partially attributed to environmental obesogenicity (Lake and Townshend, 2006). While the literature is not entirely conclusive (Black and Macinko, 2008; Feng et al., 2009; Giskes et al., 2011; Leal and Chaix, 2011), a substantial and increasing body of evidence supports associations between neighbourhood food and physical activity environments and individual obesity. In 2012, the U.S. Institute of Medicine recommended strategies designed to reduce ‘obesogenic environments’ as critical to preventing obesity (Institute of Medicine, 2012).

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Operationalizing ‘obesogenicity’ in research is conceptually and methodologically challenging but should relate to energy intake and expenditure (Feng et al., 2009; Frank et al., 2012), such that an obesogenic food environment would contribute to excess energy intake while an obesogenic activity environment would limit opportunities for energy expenditure. In studies of energy intake, availability of (i.e. number of stores within a neighbourhood) and access to (i.e., distance to the nearest store) local sources of healthy foods, such as supermarkets and green grocers, and unhealthy foods, such as fast food restaurants, are usually the focus. Existing work has provided some empirical support for links between these environmental variables and weight (Carroll-Scott et al., 2013; Kruger et al., 2013; Li et al., 2008; Liu et al., 2007; Lopez, 2007; Mehta and Chang, 2008; Morland et al., 2006; Morland and Evenson, 2009; Powell et al., 2007), but findings are not consistent (Crawford et al., 2008; Jeffery et al., 2006; Sturm and Datar, 2005; Wang et al., 2007).

Obesogenicity with respect to energy expenditure can be divided conceptually into supports/barriers to recreational physical activity and active transport. Research on recreational activity suggests the importance of access to resources such as parks, gyms, and pools (Gordon-Larsen et al., 2006; Mobley et al., 2006), although associations with obesity are less clear (Black and Macinko, 2008; Feng et al., 2009). An extensive literature has also examined a wide range of measures representing what Feng et al. (2009) term the

'land use and transportation environment' as it relates to walking and other forms of active transport (e.g., cycling). Associations with physical activity or obesity risk have been observed for land use mix (Bodea et al., 2008; Frank et al., 2004; Li et al., 2008; Mobley et al., 2006; Sarkar et al., 2013), street connectivity (Frank et al., 2004, 2008; Grafova et al., 2008; Scott et al., 2007; Spence et al., 2008), and walkability (Boehmer et al., 2007; Doyle et al., 2006; Frank et al., 2007, 2006; Michael et al., 2013; Spence et al., 2008). Perceived safety is an additional characteristic that could affect walking behaviour and obesity risk (Lumeng et al., 2006), particularly in socioeconomically disadvantaged areas (Lovasi et al., 2009).

While most previous studies have examined potentially obesogenic characteristics of the built environment as single factors, in reality these characteristics co-occur in the same neighbourhood and can have similar or opposing effects with respect to obesity risk (Wall et al., 2012). For example, a neighbourhood with a large number of fast food restaurants might be structured to encourage active transport through interconnected streets and walkable destinations. Evaluating neighbourhoods using a single aggregate index is a potentially useful way to represent the overall obesogenicity of an environment, and to quantify the association of a neighbourhood's obesogenicity with its residents' obesity risk.

The objectives of this analysis were (1) to create a conceptually based index of obesogenicity representing neighbourhood characteristics thought to be related to individual risk for adiposity, and (2) to examine its association with body mass index (BMI), both cross-sectionally at baseline and longitudinally at a 3-year follow-up, among women who participated in the Resilience for Eating and Activity Despite Inequality (READI) study, conducted in socio-economically disadvantaged neighbourhoods, both urban and rural, across Victoria, Australia.

2. Methods

2.1. Study sample

The READI cohort was established in 2007 to investigate personal, social, and structural pathways influencing obesity-related behaviours and resilience to obesity risk among women and children in the context of socioeconomic disadvantage. READI study methods are described in detail elsewhere (Ball et al., 2012). In brief, 40 urban and 40 rural suburbs in Victoria, Australia were randomly selected from among 112 urban and 661 rural suburbs in the bottom third of the Index of Relative Socioeconomic Disadvantage, a widely-used area-level indicator of disadvantage developed by the Australian Bureau of Statistics based on a variety of Census-derived socio-economic variables including income, education, employment, occupation, and housing (Australian Bureau of Statistics, 2008). Urban and rural suburbs were defined according to the Australian Regional Infrastructure Development Fund Act 1999 (Version No. 003). Urban areas included metropolitan Melbourne, other Victorian (rural) cities with a population of at least 20,000 (Geelong, Traralgon, Ballarat, Bendigo), and all suburbs completely within a 10 km radius of rural cities' centroids (Warrnambool, Wodonga). Rural areas were those falling outside metropolitan Melbourne and outside a 25 km radius of other Victorian cities.

As registration on the electoral roll is compulsory in Australia, the electoral roll was then used to identify a random sample of 150 women aged 18–45 years from each of the 80 suburbs ($n=11,940$, since some suburbs had <150 eligible women). Of the recruited women, 41% ($n=4934$) replied to a postal invitation to complete a questionnaire. Compared with non-respondents, respondents were more likely to reside in rural suburbs (54% vs. 48%) and in suburbs of less area-level socioeconomic disadvantage (mean

Index of Relative Socioeconomic Disadvantage score 948.3 vs. 938.0) (Ball et al., 2012).

Analyses excluded respondents who moved from the sampled neighbourhood before completing the survey ($n=571$), whose household addresses could not be geocoded ($n=14$), who were found to be outside of the eligible age range ($n=9$), who were not the intended participant ($n=3$), or who withdrew their data after completing the survey ($n=2$), leaving 4335 participants. We further excluded participants who reported pregnancy at baseline ($n=210$), did not provide height or weight at baseline ($n=254$), or were of unknown age ($n=48$), resulting in a baseline sample of 3823. Analyses were subsequently limited to $n=3786$ with complete data for all covariates (see below).

Of 3786 women included in baseline analyses, 1912 women completed a follow-up survey three years later (2010–2011). We excluded participants with no height or weight at follow-up ($n=300$), who reported pregnancy at follow-up ($n=64$), who were missing data on illness at follow-up ($n=4$), or whose change in BMI between baseline and follow-up was deemed unrealistic ($>115\text{ kg/m}^2$) ($n=2$), leaving a sample of 1542 for analyses on BMI at follow-up.

2.2. Data collection

2.2.1. Individual-level variables

In postal questionnaires, women self-reported their age, weight (kg), height (m), country of birth, highest education level, marital status, number of children, employment status, household income, and perceptions of their neighbourhood physical and walking environment. Although measurement error in self-reported height and weight is possible, previous work supports reasonable validity of these measures in Australian women (Burton et al., 2010).

Neighbourhood walking environment was assessed using seven questions from a scale originally described by Mujahid et al. (2007) ('My neighbourhood offers many opportunities to be physically active,' 'Local sports clubs and other facilities in my neighbourhood offer many opportunities to get exercise,' 'It is pleasant to walk in my neighbourhood,' 'The trees in my neighbourhood provide enough shade,' 'In my neighbourhood it is easy to walk places,' 'I often see other people walking in my neighbourhood,' 'I often see other people exercising (e.g. jogging, bicycling, playing sports) in my neighbourhood'), with five possible responses for each ranging from 'Strongly disagree' to 'Strongly agree.' Neighbourhood walking environment using this scale was associated with leisure time physical activity in a previous analysis in the READI cohort (Cleland et al., 2010a). Neighbourhood safety was assessed using three questions also developed by Mujahid et al. (2007) ('I feel safe walking in my neighbourhood, day or night,' 'Violence is not a problem in my neighbourhood,' 'My neighbourhood is safe from crime').

2.2.2. Neighbourhood-level variables

Prior definitions of the residential environment have varied, with existing measures either focusing on the area immediately surrounding an individual's residence within a specified buffer, or using administratively defined units. We used a combination of both based on available data and the exposure variable of interest. Buffer sizes in previous studies vary considerably, ranging primarily between 0.5 and 2 miles (Feng et al., 2009). Where available, we used a geographic buffer of 2 km (road network distance) to represent an accessible area around a participant's home. In sensitivity analyses we also used 0.8 and 3 km buffers. Other neighbourhood variables were based on data that were available only at the suburb level.

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