Preventive Medicine Reports 4 (2016) 248–255

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: http://ees.elsevier.com/pmedr

Assessing mediation of behavioral and stress pathways in the association between neighborhood environments and obesity outcomes

Samaah M. Sullivan [a,b,c,*], Edward S. Peters [c], Edward J. Trapido [c], Evrim Oral [d], Richard A. Scribner [c], Ariane L. Rung [c,**]

[a] Pennington Biomedical Research Center, Baton Rouge, LA, USA
[b] College of Humanities & Social Sciences, Louisiana State University, Baton Rouge, LA, USA
[c] Epidemiology Program, School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA, USA
[d] Biostatistics Program, School of Public Health, Louisiana State University Health Sciences Center, New Orleans, LA, USA

ARTICLE INFO

Article history:
Received 13 May 2016
Accepted 12 June 2016
Available online 14 June 2016

Keywords:
Mediation analysis
Indirect effects
Body mass index
Waist circumference
Neighborhood environments

ABSTRACT

Although many studies have reported associations between characteristics of the neighborhood environment and obesity, little is understood about the pathways or mechanisms through which these associations operate. The purpose of this study was to examine possible behavioral and stress pathways hypothesized to mediate the association between neighborhood environments and obesity and whether pathways contribute to different obesity outcomes. Cross-sectional data were used from the 2012–2014 Women and Their Children's Health Study (WaTCH) in Louisiana (N = 909). Participants' neighborhoods, body mass index (BMI) and waist circumference (WC) were objectively measured. The causal inference approach to mediation analysis was used to obtain indirect estimates for self-reported measures of physical activity, low access to food, and depression. The mean BMI was 32.0 kg/m^2 and the mean WC was 98.6 cm. The (adverse) neighborhood environment was significantly associated BMI ($\beta = 0.17$ kg/m^2; 95% Confidence Interval (CI): 0.03, 0.31) and WC ($\beta = 0.64$; 95% CI: 0.34, 0.95, after adjusting for covariates. Neither depression, physical activity, nor low food access mediated those associations. Further research that investigates and uses better measures of the behavioral and stress pathways through which the neighborhood environment influences obesity is warranted.

1. Introduction

The dramatic increase in the prevalence of obesity throughout the world during the past forty years has been called a global epidemic and is one of the most significant public health threats of the 21st century (Harris, 2013). Many epidemiologic studies have focused on understanding the modifiable factors that may help prevent and control obesity. However, biological, psychological, behavioral, and social risk factors have not been able to fully explain the obesity epidemic (Booth et al., 2005; Egger and Swinburn, 1997). Consequently, the neighborhood environment has emerged as an important risk factor for the increased prevalence of obesity during the past several decades (Booth et al., 2005; Egger and Swinburn, 1997; Glass et al., 2006; Powell-Wiley et al., 2013; Flegal et al., 2012; Hu, 2008). Aspects of the neighborhood environment can be categorized as features of the physical environment or the social environment. The physical environment, encompasses aspects of a person's surroundings which are human-made or modified, such as recreational centers, parks, playgrounds, and supermarkets (Papas et al., 2007). The social environment is defined as aspects of one's external environment or surroundings that influence how individuals socialize, live, and interact with others (e.g. crime, incivilities, and neighborhood disadvantage). A plethora of empirical research has emerged to assess the possible associations between aspects of the neighborhood environment and obesity as reviewed by Booth et al., (Booth et al., 2005) Papas et al. (Papas et al., 2007), Feng et al. (Feng et al., 2010), and Sugiyama et al. (Sugiyama et al., 2014). Despite the cache of research in this sphere of inquiry; however, little is understood about the pathways or mechanisms through which the neighborhood environment may influence obesity (Booth et al., 2005; Glass et al., 2006; Powell-Wiley et al., 2013; Papas et al., 2007; Mujahid et al., 2008). Competing theoretical frameworks propose either a behavioral pathway or a stress response pathway.

* Correspondence to: S. M. Sullivan, Pennington Biomedical Research Center, 6400 Perkins Road, Baton Rouge, LA 70808, USA.
** Corresponding author at: Epidemiology Program, School of Public Health, Louisiana State University Health Sciences Center, 2020 Gravier Street, 3rd Floor, New Orleans, LA 70112, USA.
E-mail addresses: Samaah.Sullivan@pbrc.edu, SamaahSullivan@lsu.edu (S.M. Sullivan), Epete1@lsuhsc.edu (E.S. Peters), Etrapi@lsuhec.edu (E.J. Trapido), Eoral@lsuhsc.edu (E. Oral), Rscrib@lsuhsc.edu (R.A. Scribner), Abedim@lsuhsc.edu (A.L. Rung).

http://dx.doi.org/10.1016/j.pmedr.2016.06.012

The behavioral pathway posits that the physical and social environment can influence obesity through determinants of behaviors that influence energy consumption (e.g., diet) and energy expenditure (e.g., physical activity) which in turn influence obesity (Papas et al., 2007; Hill and Peters, 1998; Popkin et al., 2005). For example, some studies have shown that characteristics of the physical environment such as accessibility to parks and recreational centers as well as proximity to fast-food restaurants and food stores are associated with adiposity, and these associations are hypothesized to operate through physical activity and dietary behaviors (Mujahid et al., 2008; Sallis et al., 2006; Sallis and Glanz, 2009; Yang et al., 2012; Black et al., 2010; Michimi and Wimberly, 2012; Michimi and Wimberly, 2010). Adverse or unsafe characteristics of the social environment (e.g., crime, disorder, incivilities, social disadvantage, and psychosocial hazards) have been suggested to influence obesity by deterring physical activity (Yang et al., 2012; Burdette et al., 2006; Christian et al., 2011; Fish et al., 2010). The stress pathway, posits that adverse neighborhood environments characterized by social and economic disadvantage and neighborhood disorder can act as chronic stressors that influence obesity through activation and dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis (Glass et al., 2006; Powell-Wiley et al., 2013; Burdette and Hill, 2008). During chronic exposure to stress, the HPA axis can be overactivated thereby increasing cortisol and subsequently adiposity and abdominal obesity (Bjorntorp, 2001; Foss and Dyrstad, 2011; Lucassen and Cizza, 2012; Pasquali, 2012; Vicennati et al., 2009). Importantly, HPA axis perturbations lead to the centralization of body fat accentuated in visceral adipose tissue which can be estimated using measures such as waist circumference, and has been suggested to be a reasonable obesity measure of long-term stress activation of the HPA axis in women (Bjorntorp, 2001; Remigio-Baker et al., 2014).

A few studies have attempted to investigate these potential pathways, and they have done so by comparing coefficient estimates between a model not including the mediator(s) and a model adjusting for the potential mediator(s) (Glass et al., 2006; Mujahid et al., 2008; Poortinga, 2006). Poortinga (2006) found that adding three different measures of physical activity to his models did not attenuate the association between perceptions of the neighborhood environment and obesity, concluding there was no evidence of mediation. Glass et al. (2006), observed that after adjusting for physical activity and diet, adults living in more adverse neighborhood environments with greater psychosocial hazards still had significantly higher odds of obesity with only a small attention of the odds ratios proposing that beyond the behavioral pathways examined, living in psychotically hazardous neighborhood may increase body weight through a stress inducing pathway. Mujahid et al. (2008), reported that physical activity and diet appeared to mediate the association between a contextual measure of the physical environment and BMI after adjusting for these variables and comparing the mean change in BMI. Importantly, none of the aforementioned studies used a formal mediation analysis to investigate potential pathways between the neighborhood environment and obesity. To our knowledge, only one previous study examined behavioral and stress processes linking neighborhood characteristics and obesity using a formal mediation analysis (Burdette and Hill, 2008). Specifically, Burdette and Hill (2008) found that perceived neighborhood disorder was associated with increased odds of obesity, which was entirely mediated by psychological distress. The association between psychological distress and obesity was fully mediated by physiological distress and poor self-rated diet quality and only partially mediated by irregular exercise (Burdette and Hill, 2008). Importantly, psychological distress was examined as a lynchpin mechanism linking perceived neighborhood disorder with obesity.

In this study, we utilized the causal inference approach for mediation analysis to investigate possible behavioral and stress pathways (specifically including self-reported measures of physical activity, low access to food, and depression) that may mediate the relationship between the neighborhood environment, and multiple obesity outcomes. Our study is unique from the previous aforementioned studies in four important ways. First, we used direct observer rating of the neighborhood environment using trained auditors. Second, we used an objective measure of BMI and further included waist circumference as a measure of central adiposity and possible phenotype of HPA axis perturbations. Also, while Burdette and Hill (2008) used a formal mediation analysis, they proposed and tested a different theoretical model linking neighborhood disorder with obesity and used the product of coefficients and Sobel test to assess mediation. Alternatively, we used the causal inference approach to mediation analysis which allows for effect decomposition of direct and indirect effects in the case of non-linearities (for binary mediators and outcome) and interactions (Valeri and VanderWeele, 2013). Investigating these potential mediators would help to estimate how much of the association between the environment and obesity is explained through each pathway and whether pathways may illuminate different processes on obesity phenotypes (e.g., stress pathway with greater abdominal obesity). Results from mediation analyses could help elucidate underlying mechanisms that may influence obesity in hopes of identifying possible mechanisms for intervention to bridge the gap between research and population health initiatives.

2. Methods

2.1. Study design and population

The Women and Their Children's Health (WaTCH) Study is a prospective cohort study established to explore the long-term health effects among women exposed to the Deepwater Horizon oil spill. The target population was women aged 18–80 years who resided in Southeastern Louisiana parishes (Orleans, St. Bernard, Jefferson, Plaquemines, Lafourche, Terrebonne, and St. Mary) before the date of the oil spill (April 20, 2010). An addressed based sampling frame was used to enumerate the target population, and women were recruited by randomly calling household telephone numbers. Baseline data, including information on individual and household characteristics, mental and social health, and health behaviors were collected using a telephone questionnaire for 2852 women between July 2012 and August 2014. Data were collected and managed using REDCap (Research Electronic Data Capture), a secure, web-based application designed to support data capture for research studies, providing: 1) an intuitive interface for validated data entry; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for importing data from external sources (Harris et al., 2009). Medical research assistants collected anthropometric measurements and neighborhood audits on a sub-sample of women who participated in the home visit portion of the study (N = 1233). P-values for differences between women who participated in the WaTCH telephone questionnaire and women who participated in the home visit portion of the study are presented in Supplementary Table 1. Women who participated in the home visit portion of the study were more likely to be African American (P = 0.0064), have lower household income (P = 0.0002), report greater depressive symptoms ≥16 (0.0072), were more likely to report low food access (P < 0.0001), and report greater oil spill exposure (P = 0.0494). The WaTCH study was approved by the Louisiana State University Health Sciences Center Institutional Review Board and was granted a Waiver of Documentation of Informed consent for the telephone interview for which women gave verbal consent. Women who participated in the home visit portion of the study further provided written informed consent. More detailed information on the WaTCH study has been described elsewhere (Peres et al., 2016; Rung et al., 2016).

2.2. Obesity measures

Body height, weight, and waist circumference were objectively measured using standardized procedures by trained medical research