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Original article

Social determinants of disparities in weight among US children and adolescents

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ABSTRACT

Purpose: To explore whether contextual variables attenuate disparities in weight among 18,639 US children and adolescents aged 2 to 18 years participating in the National Health and Nutrition Examination Survey, 2001 to 2010.

Methods: Disparities were assessed using the Symmetrized Rényi Index, a new measure that summarizes disparities in the severity of a disease, as well as the prevalence, across multiple population groups. Propensity score subclassification was used to ensure covariate balance between racial and ethnic subgroups and account for individual-level and contextual covariates.

Results: Before propensity score subclassification, significant disparities were evident in the prevalence of overweight and/or obesity and the degree of excess weight among overweight/obese children and adolescents. After propensity score subclassification, racial/ethnic disparities in the prevalence and severity of excess weight were completely attenuated within matched groups, indicating that racial and ethnic differences were explained by social determinants such as neighborhood socioeconomic and demographic factors.

Conclusions: The limited overlap in covariate distributions between various racial/ethnic subgroups warrants further attention in disparities research. The attenuation of disparities within matched groups suggests that social determinants such as neighborhood socioeconomic factors may engender disparities in weight among US children and adolescents.

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Introduction

The monitoring and elimination of health disparities is a primary goal of the US Healthy People 2020 initiative; [1] low-income and some racial and ethnic minority groups are more likely to suffer from obesity and a variety of weight-related diseases [2–10]. Racial/ethnic and economic residential segregation leads to differential access to beneficial and adverse exposures for various subpopulations [11–14], as some racial and ethnic subpopulations are more likely to reside in neighborhoods characterized by social and structural disadvantage [11–13]. Inequities in the built and social environments have increasingly been the focus of research seeking to explain weight-related and other disparities [11–20].

There are also racial/ethnic disparities in the prevalence of extreme obesity among children [9,21–23]; these disparities are evident as young as preschool and observed within limited socioeconomic strata such as low-income samples [24,25]. Most prior studies have examined differences in the proportion of children falling above various body mass index (BMI) cutoffs (e.g., 97th or 99th percentile [9,22,23], 1.2 times the 95th percentile [21,26]). National estimates for the United States suggest that non-Hispanic black children are nearly twice as likely to fall above the 97th BMI percentile for age and sex compared with non-Hispanic white children (18.6% vs. 9.8%, respectively), and rates are also high among Hispanic children (15.6% [9]). Few studies have examined whether there are disparities in the severity of excess weight among overweight or obese children on a continuous scale. Differences in the burden of excess weight within the overweight or obese category are important because of the increased risk of weight-related comorbidities associated with higher levels of excess weight [23,27–32]. Moreover, extreme obesity among children and adolescents is associated with elevated leptin levels, placing these children and adolescents at high risk of further weight gain and poor responsiveness to weight-loss interventions [27].

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the National Center for Health Statistics, Centers for Disease Control and Prevention.

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Table 1
Variables included in propensity score estimation.*

Individual or household-level variables from NHANES 2000–2010:
Caregiver marital status†: married or cohabitating; single/divorced/widowed
Age
Sex
Household Income-to-Poverty Ratio†
Caregiver education†: less than high school; high school degree; some college or higher
County-level variables:
Segregation indices‡
Dissimilarity Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)|p_{k,m}-p_m|$
Information Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)p_{k,m}\ln\left(\frac{p_{k,m}}{p_m}\right)$
Normalized Exposure Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)\frac{(p_{k,m}-p_m)^2}{(1-p_m)}$
Exposure Index (black vs. white):
$\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)\left(\frac{p_{\text{black}}p_{\text{white}}}{p_{k,\text{black}}}\right)$
Gini Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\sum_{l=1}^{K}\left(\frac{t_k}{T}\right)\left(\frac{t_l}{T}\right)|p_{k,m}-p_{lm}|$
Relative Diversity Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)(p_{k,m}-p_m)^2$
Squared Coefficient of Variation Index:
$\sum_{m=1}^{M}\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)\frac{(p_{k,m}-p_m)^2}{p_m}$
Isolation Index (black vs. white):
$\sum_{k=1}^{K}\left(\frac{t_k}{T}\right)\left(\frac{p_{\text{black}}p_{\text{black}}}{p_{k,\text{black}}}\right)$
Urban/rural category§: large central metropolitan; large fringe (population ≥ 1 million); medium fringe (population 250,000–999,999); small fringe (population <250,000); micropolitan; rural.
Arrests per 1000 population‖
Proportion of county that is urban
Square miles
Census tract-level¶ variables
Proportion of vacant housing units
Proportion of owner-occupied housing units
Median housing unit value
Deprivation Index#

* State and survey year were also included in propensity score models.
† Caregivers who did not report education level, marital status, or income were still included in models as these covariates included dummy-codes for missingness.
‡ Segregation indices constructed using county-level population data from the RAND Center for Population Health and Health Disparities Data Core Series. All county-level segregation indices are normalized to take values between 0% and 100%, where 0 indicates no segregation [64]. For all 8 county-level segregation indices: T is the total population; p_m is the proportion of the population in group m (e.g., non-Hispanic black); M is the number of racial/ethnic groups (here, $M = 5$); t_k is the number of individuals in county k; K is the total number of counties; $p_{k,m}$ is the proportion of individuals in group m for county k.
§ From the National Center for Health Statistics Urban-Rural Classification Scheme.
‖ Data are drawn from the U.S. Federal Bureau of Investigation Uniform Crime Reporting Program for the year 2000.
¶ All tract-level population data are drawn from the year 2000 decennial U.S. Census.
\# Tract-level deprivation index is constructed by first standardizing then averaging the following variables: proportion of adults over 25 years with less than a high school education; proportion of males over 16 years who are unemployed; proportion of families below the poverty threshold; proportion of households receiving public assistance; proportion of female-headed households with children; and median household income. These variables were transformed for normality and direction, and their Z-scores were averaged; higher values indicate worse SES profile.

A handful of studies have examined social determinants of weight disparities. One limitation of these studies is the narrow overlap in the distribution of exposures between racial/ethnic subgroups, [33] leading to off-support inferences when traditional regression-based methods do not fully account for confounding [34–36]. Propensity score methods can be used to ensure samples are balanced on potential confounders such as neighborhood socioeconomic factors [36–38]. Few studies have used propensity score matching to examine racial/ethnic disparities [36]. Do et al. [39] reported that the gap in self-rated health between black and white adults was fully explained when using propensity score matching methods to control for socioeconomic status (SES) at the individual and neighborhood levels. A previous study on the same topic using traditional regression-based methods reported that only 15% to 76% of the gap in self-reported health was explained, although this analysis used a different sample and covariates, so is not directly comparable [16].

The objective of this study was to explore whether contextual variable attenuate racial/ethnic disparities in the prevalence and severity of overweight and obesity among children and adolescents in the United States using the newly developed Symmetrized Rényi Index (SRI). There are several advantages to the SRI. It is invariant to the choice of the reference group for evaluating disparities and is more robust to changes in the outcome distribution than alternatives that are based on the commonly used generalized entropy class [40]. The SRI allows for the examination of disparities in the severity of a disease and the prevalence, across multiple groups. The SRI also allows for the groups to be weighted equally or according to population size, an important consideration in the measurement of health disparities as each method is associated with an implicit value judgment concerning the importance of the disease burden for an individual versus the disease burden of a group [41–46]. Although the SRI has been previously used to examine disparities in selected oral health outcomes and blood cholesterol levels, [40,47,48] the use of a covariate-adjusted SRI to examine health disparities has not yet been established.

There are three principal contributions of this article over existing literature. First, a variety of social determinants were examined in relation to weight disparities, including neighborhood-level sociodemographic and economic characteristics and segregation indicators. Second, propensity score subclassification was used to improve covariate balance across racial/ethnic groups and to produce a covariate-adjusted health disparity index, going beyond prior descriptive (unadjusted) analyses. Third, in the absence of an exact reference distribution, this article provides a sound empirical procedure for testing the statistical significance of the SRI in the context of complex survey data, as described in the Appendix.

Materials and methods

Data sources and study population

Data were from 18,639 children and adolescents aged 2 to 18 years who participated in the examination component of the National Health and Nutrition Examination Surveys (NHANES) from 2001 to 2010. NHANES is a cross-sectional survey of the civilian, noninstitutionalized US population conducted continuously in 2-year survey cycles [49]. NHANES uses a complex multistage probability sampling design, with some subgroups oversampled. Standardized weight and height measures collected in the 2001 to 2010 examination component of NHANES were used to calculate age- and sex-specific BMI percentiles for children and adolescents aged 2 to 18 years, according to the 2000 Centers for Disease Control and Prevention growth charts [50,51]. Children were classified as overweight or obese if they had a BMI percentile of 85 or more. Other variables in the NHANES public-use data files include age, sex, race/ethnicity, income-to-poverty ratio, caregiver education level (i.e., <high school, high school, >high school), and caregiver marital status (i.e., single/divorced/widowed, married/cohabitating). Of the eligible sample, 440 were excluded because of