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Residential property values are associated with obesity among women in King County, WA, USA

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Abstract

Studies of social determinants of weight and health in the US have typically relied on self-reported education and incomes as the two primary measures of socioeconomic status (SES). The assessed value of one's home, an important component of wealth, may be a better measure of the underlying SES construct and a better predictor of obesity. The Seattle Obesity Study (SOS), conducted in 2008-9, was a cross-sectional random digit dial telephone survey of 2001 adults in King County, Washington State, US. Participants' addresses were geo-coded and residential property values for each tax parcel were obtained from the county tax assessor's database. Prevalence ratios of obesity by property values, education, and household income were estimated separately for women and men, after adjusting for age, race/ethnicity, household size, employment status and home ownership. Among women, the inverse association between property values and obesity was very strong and independent of other SES factors. Women in the bottom quartile of property values were 3.4 times more likely to be obese than women in the top quartile. No association between property values and obesity was observed for men. The present data strengthen the evidence for a social gradient in obesity among women. Property values may represent a novel and objective measure of SES at the individual level in the US. Measures based on tax assessment data will provide a valuable resource for future health studies.

Keywords

USA; obesity; health status disparities; social class; health surveys; socioeconomic factors; women

INTRODUCTION

Low socioeconomic status (SES) is an important determinant of chronic disease (e.g., Galea et al, 2011; Marmot 2005) and weight gain (Purslow et al., 2008). Low SES has been linked to higher rates of obesity, diabetes, and the metabolic syndrome both at the individual (e.g., Loucks et al., 2007; Banks et al., 2006) and in ecologic analyses for political districts (Drewnowski et al., 2009), ZIP code areas (Drewnowski et al., 2007), and counties (Murray

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et al 2005). However, area based measures of SES may be of limited value in obesity research when the level of inference is the individual (Krieger et al., 2005).

In the US, self-reported education and income continue to be used as the primary measures of SES in obesity studies (e.g., Ogden et al., 2010; Loucks et al., 2007). The association between obesity, education and income varies by gender and race, and is strongest among non-Hispanic white women (Ogden et al, 2010). Since obesity is the result of weight gain over a number of years, long-term measures of material advantage or disadvantage seem most appropriate for obesity research. A limited number of studies have linked measures of accumulated wealth with reduced likelihood of obesity or with lower body mass index (BMI) (Clarke et al., 2010; Fonda et al., 2004; Hajat et al., 2010). One challenge in assessing wealth in health studies is the respondent burden and need to ask a number of sensitive questions about material assets.

Property values may capture both the material and psychosocial aspects of SES more completely than do income or education (e.g., Braveman et al., 2005; Pollack et al., 2007). First, property values represent the second largest source of wealth in the US, following stocks and bonds (Di et al., 2003) and may reflect accumulated resources and wealth better, while education or current income ignore aspects of accumulated resources. Second, data from the county tax assessor represent an objective measure of SES as opposed to one obtained from self-report. Third, property values can be obtained for tax parcels, representing an objective household-level measure of SES. Finally, property values are publicly available in many jurisdictions, allowing the variable to be linked to participant address data without imposing additional respondent burden.

Property values may also provide some insights into the social and environmental mechanisms linking SES and BMI. Community resources, amenities and social capital, as well as gendered cultural attitudes to body weight, may promote or hinder the development of obesity and are likely reflected in home values. Thus home values may be proxies for the environmental, psychosocial, and economic factors linking SES to body weight. Aspects of the built environment, such as limited access to supermarkets and grocery stores selling healthy foods have been linked with higher obesity rates in the US (Lovasi et al., 2009). In addition, walkable neighborhoods and proximity to parks, trails and physical activity amenities are generally associated with lower body weights and better health outcomes (Auchincloss et al., 2009). Food insecurity, depression, and stress, may additionally link SES with obesity (Franklin et al., 2011; Institute of Medicine 2011). The low-cost and availability of energy-dense foods in deprived areas may also promote overeating and weight gain among individuals with low SES (Drewnowski & Specter 2005). As noted, the SES-obesity gradient in the US has consistently been observed to be strongest among women, especially white women. The mechanisms explaining the SES gradient among women are not clear, but may be related to parity, greater experiences of stress or depression associated with low SES or a stronger gradient between SES and diet quality among women (e.g., Loucks et al., 2007; Beydoun & Wang, 2008).

Property values from tax rolls are a promising measure for the study of SES disparities in obesity. This study, based on a sample of 2,001 non-institutionalized adults living in King County, WA sought to determine whether obesity would be most strongly associated with property values, education, or incomes.

METHODS

Population and survey instrument

A 20-minute telephone survey was administered to a stratified random sample of 2,001 adult residents of King County, Washington State, US from October 2008 to March 2009.

Potential respondents received a pre-notification letter advising that they had been randomly selected to take part in a study and would be contacted by telephone. Their telephone numbers were matched with residential addresses using commercial databases, and were confirmed by respondents. Sampling, address matching, and survey administration for the Seattle Obesity Study (SOS) were conducted by the same company that conducts the annual Behavioral Risk Factor Surveillance System (BRFSS) survey for the state and local health departments in Washington State. Any adult living in the household was eligible to participate. Only one adult could be sampled from any single residential unit (e.g., single family home or apartment unit). The SOS respondent sample was comparable to the King County adult population in terms of race/ethnicity, income and household size.

The SOS survey questions were modeled on BRFSS. Data were obtained on age, gender, race/ethnicity, education, employment status, household income, and home ownership. Height and weight were also collected. The primary outcome measure was obesity, defined as a BMI ≥ 30 (kg/m²). The survey was approved by the IRB at the University of Washington (9/22/2008).

Geocoding of survey respondents

Addresses of respondents were geocoded to their home parcel. Geocoding was done using ArcGIS software. Address records that did not obtain a perfect score in automatic geocoding were manually matched using a digital map environment with annotated layers from the reference data augmented by online databases. A home parcel may be a single-family detached home, duplex/triplex or apartment building/complex among many possibilities. The average size of home parcels in this study was 1.15 acres (4,654 m²) and the median area was 0.2 acres (800 m²). In this study, the average number of units per parcel was 17.9 and the median was 1.

Property Values

Assessed residential property values were obtained from the 2008 King County tax assessor parcel database. Property values are determined by the combined value of both land and improvements (buildings and other structures), and based on recent local sales data. For home parcels with multiple residential units (e.g., apartment buildings), assessed value per unit was calculated as the sum of a parcel's land and improvement values divided by the number of residential units on the parcel. Tax assessment in WA State aims to estimate the full market value of a given property (King County Department of Assessments). The primary exposure of interest was the mean assessed property value per residential unit in the parcel where the respondent lived.

Statistical Analysis

Criteria for inclusion in the analyses were: (1) respondents whose addresses could be geocoded, (2) those who provided both height and weight, and (3) those providing all of the following covariates: age, race/ethnicity, employment, home ownership, and education (with the exception of income). The final sample size was 1,824 (91% of initial sample). The distribution of age, education, ownership of home, employment, and household income of those with complete and missing data were similar. Women were slightly more likely to be excluded, primarily because of missing information on height/weight.

The three measures of SES were education, income, and property values. Household income was defined as 6-level categorical variable and education was defined as a 3-level categorical variable. Quartiles were created for property values since there were no natural cut-points.

Identification of significant interactions by gender and income ($p=0.007$), and gender and property values ($p=0.017$) necessitated calculating separate estimates for men and women. No gender-SES interaction was observed for education, but these data were also stratified for purposes of comparison. An interaction model was fit including age, a quadratic term for age, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific Islander and other), home ownership (yes/no), and employment (employed, homemaker, student, retired, and out of work or unable to work) (Model 1). A second model evaluated education or income, with adjustment for the other SES measure and all other factors from Model 1 (Model 2). A final model evaluated all three measures of SES simultaneously with adjustment for factors from Model 1 (Model 3). An additional analysis evaluated property values among individuals who reported owning a home and those who did not.

Ninety-four percent of respondents lived in unique parcels. The average number of respondents per parcel was 1.08 and the maximum was 5. While some respondents lived in the same parcel, no respondents lived in the same apartment unit or single-family home as another respondent. Because the number of respondents clustered in parcels was relatively small and no respondents lived in the same residential unit as another respondent, multi-level analysis approaches were not used.

A generalized linear model with a Poisson link and robust standard errors was used to estimate the prevalence ratio of obesity for each level of SES compared to a referent category (Zou, 2004). Robust standard errors were used, in part, to account for some clustering of individual within parcels. Grouped linear variables were included for ordered categorical variables to test for a linear trend. All analyses were conducted using Stata 11.0.

RESULTS

The final respondent sample and average property values are provided in Table 1. Property values varied 154-fold, from \$19,907 to \$3 million. The average value was \$328,267 and the median was \$273,000. Older individuals, non-Hispanic whites, college educated, higher income and homeowners had higher property values. Employed individuals, retired individuals and homemakers also had high property values. While education, income and property values were correlated with each other, they did not approach collinearity.

In a minimally adjusted model (Table 2, Model 1) having less education was associated with an increased likelihood of being obese for both genders. After adjusting for income, there was a weak association between education and obesity for both genders. Upon adjustment for property values that association between education and obesity disappeared among women, but remained for men. For men, the association between income and obesity was somewhat attenuated by including education in the model, and fully attenuated after adjusting for individual property values (Model 3 in Table 2). In Model 1, women with low incomes were 3.5 times more likely to be obese than women with the highest incomes. The association was marginally attenuated after adjusting for education (Model 2). After adding property values the association was more fully attenuated. Bivariate results are available in the Electronic Appendix (Table 2)

Women living in homes with the lowest property values were 3.4 times more likely to be obese than women living in homes with the highest property values, after accounting for education and income. A significant trend in the association between property values and

obesity among women was observed. Property values were not associated with obesity among men.

Secondary analyses separated renters from homeowners (Electronic Appendix [Table 3]). Compared to female homeowners in the highest category of property values, renting was associated with a 3.2-fold increase in the prevalence of obesity, independent of other factors, while owning a low value home was associated with a 3.7 fold increase in the prevalence of obesity.

DISCUSSION

To our knowledge, this is the first study in the US linking assessed property values at the individual-level to obesity among adults. For women, the inverse association between the prevalence of obesity and the value of their home was strong and independent of education and incomes.

Numerous mechanisms may explain the observed association between property values and obesity among women. First, property values may capture some aspects of the underlying SES construct better than education or income. The association between income and obesity was attenuated after adjusting for property values; suggesting that the value of one's home represents an important additional component of SES not captured by income. Separating homeowners from renters did not change the results, as the prevalence of obesity among women owning a low value home was comparable to that of renters.

For many, the value of their home is one of their principal assets and a measure of net wealth (Di et al., 2003). Several studies have linked BMI and obesity with measures of net worth obtained by self-report (Clarke et al., 2010; Fonda et al., 2004; Hajat et al., 2010). One such study observed a strong association higher wealth and lower risk of obesity, but did not evaluate effect modification by gender (Hajat et al., 2010). One study showed that low net worth was associated with higher BMI among women, but with lower BMI for men (Fonda et al., 2004). Two studies argued that low net worth was a consequence rather than a risk factor of obesity (Clarke et al., 2010; Fonda et al., 2004).

Property values have been used as a proxy measure of accumulated wealth or SES for many health outcomes. One study observed a positive association between higher property values and self-reported health (Moudon et al., 2011) and another linked higher individual level property values with a reduced risk of cardiac arrest (Butterfield et al., 2011). Using aggregated data, higher property values at the ZIP code level were associated with a lower prevalence of adult obesity (Drewnowski et al., 2007). Other studies have observed a positive association between property values and seat-belt use and the likelihood of receiving bystander CPR (Shinar, 1993; Vaillancourt et al., 2008). Recently, a study evaluating fast food restaurant proximity and childhood obesity used property values as a proxy for SES, observing that lower property values were associated with childhood obesity (Mellor et al., 2011). Because no other SES data were collected, the effect of property values could not be compared with other measures.

Assessed property values may represent a unique resource for future studies as they reflect absolute financial resources in an environmental context. Individuals living in less valuable residences may be concentrated in neighborhoods with fewer resources, including healthy food retailers, parks or trails (Auchincloss et al., 2009; Lovasi et al., 2009). The compositional and contextual effects may also contribute to increased individual stress and lower levels of social support (Burdette & Hill, 2008; Moore, et al., 2009). Future research should explore these potential mechanisms. The present hypothesis is that features of the

built environment believed to promote or prevent obesity will be reflected, to some extent, in property values.

Our study had a number of strengths. First, assessed property values from local records are an objective measure of SES, which may reduce problems due to the high degree of missing data on income in most studies. These data are regularly updated and often freely available. However, such data do require the additional cost of obtaining addresses from respondents and using GIS to geocode and link them to parcels.

This study had some limitations worth noting. First, the outcome was based on self-report from a telephone survey. This is subject to known error, especially the under-reporting of weight and over-reporting of height (Stommel & Schoenborn, 2009). Such error would only bias the results if persons in the higher SES strata underreported their weights (or over reported their heights) more than persons with lower SES. There is little evidence to suggest that this is the case (Ezzati et al., 2006) and some evidence to suggest that lower-income women over-report their heights more than higher-income women, resulting in a greater bias between true and measured BMI for lower-income women (Merrill & Richardson, 2009). Such differential bias would suggest that the association observed here might, in reality, be larger. Second, the results for King County may not be generalizable to other settings, as data from multiple housing markets may be influenced by market differences and data quality. In addition, King County is more affluent than other parts of the US, which may further limit generalizability. The representativeness of the study sample may be an additional limitation, yet secondary analyses comparing weighted results to those presented here showed similar associations between SES and obesity. Finally, given the study's cross-sectional design we cannot discount reverse causality. Obese persons, especially women, face discrimination, which may reduce economic opportunities through employment (Brownell, 2005; Puhl et al., 2008) or reduced wages (Cawley et al, 2004). These factors may explain the observed effect modification by gender. Restricting the analysis to people who reported living in their homes for more than 10 years (56%) suggested that the association between property values and obesity did not differ based on length of residence, allaying our concerns regarding reverse causation. Prospective studies should be used to fully assuage these concerns.

Despite these limitations, the present results show that property values were significantly and strongly associated with obesity among women. Though consistent with previous research, this approach should be extended to other contexts using more robust study designs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research Highlights

- Income and education may not capture all relevant aspects of SES in health research.
- Property values have been previously used as a measure of SES and wealth, though they have not been applied to obesity among adults.
- Among women in this study in King County, Washington State, USA, property values were strongly associated with obesity.
- Property values may represent an underutilized resource for objective data on SES not captured by education or income.

Table 1

Characteristics of Seattle Obesity Study (SOS) Respondents and Mean Property Values by Socio-demographic Group

	N	Percent (%)	Mean Property Value (\$)
Total	1,824	100.0	328,267
Age			
18-29	93	5.1	261,458
30-44	380	20.8	312,130
45-64	905	49.6	333,170
65	446	24.5	325,309
Gender			
Female	1,103	60.5	331,273
Male	721	39.5	310,922
Race/ethnicity			
Non-Hispanic white	1,469	80.5	332,840
Non-Hispanic black	121	6.6	251,550
Hispanic	48	2.7	244,278
Asian	146	8.0	333,407
Other	40	2.2	245,461
Education			
<High school	343	18.8	240,584
Some college/technical school	477	26.1	269,611
College graduate	1,009	55.2	376,818
Employment Status			
Employed	1,099	60.2	322,695
Homemaker	106	5.9	443,937
Student	36	2.0	278,658
Retired	427	23.4	335,878
Unemployed/unable to work	156	8.6	222,793
Household Income (\$1,000)			
<25	223	13.6	201,998
25-34.9	166	10.1	233,418
35-49.9	262	16.0	258,636
50-74.9	310	18.9	298,488
75-99.9	255	15.6	322,902
100	421	25.7	459,690
Missing	187		373,644
Home ownership			
Own	1,437	78.8	360,126
Rent	387	21.2	185,897
BMI Category			
Healthy weight/underweight (<24.9)	808	44.3	363,362
Overweight (25-29.9)	636	34.9	311,779

	N	Percent (%)	Mean Property Value (\$)
Obese (30)	380	20.8	256,869

Table 2
Adjusted Prevalence Ratio of Obesity by Measures of SES, Stratified by Gender

	Model 1 ^a			Model 2 ^b			Model 3 ^c			
	Men	Women		Men	Women		Men	Women		
	PR ^d	95% CI	PR ^d	95% CI	PR ^d	95% CI	PR ^d	95% CI	PR ^d	95% CI
Education										
<High school	1.5 [*]	1.1, 2.1	1.7 [†]	1.2, 2.3	1.3	0.9, 1.9	1.4 [*]	1.0, 2.0	1.3	0.9, 1.8
Some college/technical school	1.1	0.8, 1.6	1.5 [†]	1.1, 2.0	1.0	0.7, 1.4	1.3	1.0, 1.7	1.0	0.7, 1.6
College graduate	ref		ref		ref		ref		ref	
P-trend ^e	0.008		0.001		0.055		0.089		0.048	0.6
Household income										
<\$25,000	1.3	0.8, 2.3	3.5 [‡]	2.1, 5.8	1.2	0.7, 2.0	3.1 [‡]	1.9, 5.3	0.9	0.5, 1.6
\$25,000-\$34,999	2.1 [†]	1.2, 3.4	2.2 [†]	1.3, 3.8	1.8 [*]	1.1, 3.0	2.0 [*]	1.1, 3.5	1.3	0.8, 2.2
\$35,000-\$49,999	1.5	0.9, 2.5	3.1 [‡]	2.0, 4.9	1.4	0.9, 2.3	2.9 [‡]	1.8, 4.6	1.1	0.7, 1.8
\$50,000-\$74,999	1.5	1.0, 2.3	1.6	0.9, 2.6	1.4	0.9, 2.1	1.5	0.9, 2.5	1.1	0.7, 1.6
\$75,000-\$99,999	1.1	0.6, 1.7	2.1 [†]	1.3, 3.5	1.1	0.6, 1.7	2.0 [†]	1.3, 3.3	0.9	0.5, 1.4
\$100,000	ref		ref		ref		ref		ref	
P-trend ^e	0.036		<0.001		0.17		<0.001		0.31	0.035
Property values										
\$19,907-\$208,000	1.4	0.9, 2.1	3.4 [‡]	2.2, 5.3	-	-	-	-	0.9	0.5, 1.6
\$208,001-\$272,000	1.7 [*]	1.1, 2.5	3.2 [‡]	2.1, 4.9	-	-	-	-	1.1	0.7, 1.8
\$272,001-\$379,590	1.0	0.6, 1.6	1.6	0.9, 2.6	-	-	-	-	0.8	0.5, 1.3
\$379,591-\$3,069,000	ref		ref		-	-	-	-	ref	
P-trend ^e	0.022		<0.001		-		-		0.33	<0.001

Pairwise comparisons of each prevalence ratio to the reference group were also made. The p-values for these comparisons correspond to the following symbols,

^a Adjusted for race/ethnicity, home ownership, employment status, age and age². Household income is adjusted for number of household members.

- ^b Adjusted for factors in Model 1. Income model is adjusted for education and education model is adjusted for income.
- ^c Adjusted for factors in Model 1 and mutually adjusted for all other SES measures (income, education and property values).
- ^d PR is prevalence ratio
- ^e P for trend calculated by including a grouped linear variable in the model. For example, education was coded as follows: <HS=1, some college=2, college=3.
- * 0.01<p<0.05
- [†] 0.001<p<0.01
- [‡] p<0.001