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Associations between Multiple Indicators of Socioeconomic Status and Obesity in Young Adult Filipinos Vary by Gender, Urbanicity, and Indicator Used[1,2]

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Abstract

More research is needed on the socio-environmental determinants of obesity in lower- and middle-income countries. We used generalized estimating equations to evaluate the cross-sectional effect of urban residence and multiple individual-level indicators of socioeconomic status (SES) on the odds of overweight or central adiposity in a birth cohort of young adult (mean age 21.5 y) Filipino males (n = 987) and females (n = 819) enrolled in the Cebu Longitudinal Health and Nutrition Survey. Overweight was defined as BMI $\geq$25 kg/m^2 and central adiposity was defined as a waist circumference >85 cm for males or >80 cm for females. Community-level urbanicity was measured on a continuous scale. Multiple indicators of SES included assets, income, education, and marital status. In the final multivariable models, assets and being married were positively related to overweight and central adiposity in males ($P < 0.05$), but being married was the only predictor of these outcomes in females. However, once the modifying effects of urban residence were accounted for, assets were positively related to overweight and central adiposity among the most rural women, but not in more urban women. Our results are consistent with a growing body of literature that suggests the relationship between SES and obesity is positive in lower-income contexts and inverse in higher-income contexts, particularly in females. The pattern of relationships we observed suggests that as the Philippines continues to develop economically, the public health impact of obesity will increase similarly to what has been observed in countries further along in their economic transition. J. Nutr. doi: 10.3945/jn.109.114207.

Introduction

Obesity negatively affects human health by directly affecting psycho-social well-being and by increasing the likelihood of various other diseases (1). Once viewed as a predominantly Western problem, obesity has also emerged as a serious public health problem in many lower- and middle-income countries (2–4). The increasing prevalence of obesity in these contexts is broadly driven by socioeconomic development, which in turn promotes obesogenic dietary and activity behaviors (4). Consequently, there is a substantial body of research focused on the association between socioeconomic status (SES)[6] and obesity.

Sobal and Stunkard (5) published the first major review of studies reporting associations between SES and obesity. Their review highlighted the importance of "social research" in explaining the global rise in obesity prevalence and provided compelling evidence that the burden of obesity in higher-income countries was disproportionately placed on the poor, particularly among women. Conversely, their review found that obesity was largely a problem associated with affluence for both men and women in lower-income countries. However, evidence soon emerged from Brazil that suggested that the burden of obesity was shifting toward lower SES strata (6,7). This inverse SES-obesity relationship has now been observed in a variety of lower- and middle-income contexts (8–12). Furthermore, evidence suggests that this shift progresses as a function of economic development and urbanization (10–12).

An important gap in this literature is that most previous studies have focused on single indicators of SES such as education or income, or composite scores that combined multiple indicators. However, some studies have found contrasting effects of individual SES indicators, such as income and education (e.g. 13). Consequently, our interpretation of the

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[6] Abbreviations used: CLHNS, Cebu Longitudinal Health and Nutrition Survey; GEE, generalized estimating equation; ICC, intra-class correlation; OR, odds ratio; PHP, Philippine peso; SES, socioeconomic status; WC, waist circumference.
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relationship between SES and obesity in a particular context may be influenced by the SES indicator investigated. Thus, understanding the concurrent effects of multiple SES indicators could yield important etiological insights.

Our primary goal was to help address this gap by investigating cross-sectional associations between obesity and multiple indicators of SES in a birth cohort of young adults enrolled in the Cebu (Philippines) Longitudinal Health and Nutrition Survey (CLHNS). We also tested the hypothesis that the SES-obesity gradient would vary as a function of urban development at the intra-regional level, using a continuous scale measure that captures urban heterogeneity within a contiguous area (14). This contrasts with, and complements, previous studies that have examined differences in the SES-obesity relationship across different levels of economic development, either by comparing countries (10,11) or distinct geographical regions within countries (13).

Materials and Methods

Study design and sample. Data are from the CLHNS, a community-based study of a 1-y birth cohort living in Metropolitan Cebu (population 1.9 million), Philippines. The study area includes 270 administratively defined communities called barangays (average area 2.65 km^2), comprising a 720-km^2 contiguous area. A single-stage cluster sampling procedure was used to randomly select 33 barangays, and pregnant women residing in these barangays were recruited for the study in 1982 and 1983. Those who gave birth between May 1, 1983 and April 30, 1984 were included in the sample. More than 95% of identified women agreed to participate. A baseline interview was conducted among 3327 women during mo 6 or 7 of pregnancy. Another survey took place immediately after birth; there were 3080 nontwin live births in the CLHNS birth cohort. Subsequent surveys were conducted bi-monthly to age 2 y, then in 1991, 1994, 1998, 2002, and 2005. The CLHNS protocols were reviewed and approved by the Institutional Review Board of the University of North Carolina at Chapel Hill.

We used 2005 birth cohort data (n = 1885) when the study participants were young adults (mean age 21.5 y). Women pregnant in 2005 were excluded (n = 73). Anyone with missing data on variables of interest were also dropped (4 males and 2 females), resulting in a final sample of 987 males and 819 females (96% of the total 2005 sample).

The analysis sample of 1806 males and females is 59% of the original 3080 single live births recruited for the study. This is overwhelmingly due to the loss to follow-up characteristic of longitudinal studies of this length. The 1806 individuals included in this analysis sample did not differ at baseline (1983) from the 1274 single live births also recruited at baseline (by t test or chi square; $P \leq 0.05$) in mean household income and assets or maternal education, BMI, and height. However, the analysis sample did have slightly higher birth weights [difference 0.06 kg (95% CI: 0.03–0.09)] and lengths [difference 0.18 cm (95% CI: 0.03–0.33)]. The gender distribution was also different in 2005 than at baseline (45 vs. 49% female).

Measures. Body size measures were collected by trained field staff during in-home interviews using techniques described in Lohman et al. (15). Weight was measured with a mechanical scale to the nearest kilogram, while height was measured with a folding stadiometer to the nearest tenth of a centimeter. BMI was calculated as weight (kg) divided by height (m) squared. Waist circumference (WC) was measured in cm at the midpoint between the bottom of the ribs and the top of the iliac crest. BMI is a measure of weight adjusted for height. Although BMI does not describe fat distribution or differentiate fat mass from lean body mass, it is a reasonably good predictor of overall body fat (16,17). WC is a measure of centrally distributed adipose tissue, which is thought to be particularly relevant for a number of disease outcomes (18). Based on these 2 measures, we dichotomously defined overweight as BMI $\geq$25 kg/m^2 and central adiposity as a WC >85 cm for males and a WC >80 cm for females (19). Though these cutpoints are fairly low, evidence suggests that risk of cardiovascular disease outcomes rises at lower levels of fatness in Asian than in Caucasian populations (20).

In-home interviews were used to assess weekly household income, measured in Philippines pesos (PHP) and deflated to 1983 values. Housing quality and assets indicators were used to create a continuous measure of household assets derived from a principal components analysis (21). Education, based on the highest grade completed by the study participant, was categorized using indicator variables as: no schooling or any primary school; attended any secondary school; and attended any college. Marital status was determined by asking participants whether they were living with a spouse or partner (yes/no).

We used 1 community-level variable, urbanicity, which refers to the urban nature of a barangay. While most researchers use the urban-rural dichotomy to describe urbanicity, we used a continuous measure that captures a range of variation in urbanicity (from rural to highly urban) across a single dimension (14). Briefly, the scale is made up of 7 components derived from data collected for the CLHNS barangay level surveys: population size; population density; communications (availability of mail, telephone, internet, cable TV, and newspaper services); transportation (paved road density and public transportation services); markets (presence of gas stations, drug stores, grocery stores, and the number of small commercial kiosks); educational facilities; and health services. Theoretically, the scale represents an underlying latent construct, labeled urbanicity, that is imperfectly reflected in each of these 7 components and could be viewed as a localized proxy for economic development.

Statistical methods. Due to the design of the CLHNS, individuals are clustered by barangay of residence. Because social and built environments influence obesity risk (22–24), we expect individuals living in the same barangay to be more similar to each other, with respect to obesity outcomes, than they are to individuals living in other barangays (i.e. observations within barangays are statistically dependent). This dependence was confirmed in a preliminary analysis, for which we used empty random-intercept logistic regression models to estimate the intra-class correlations (ICC) for overweight and central adiposity in our sample. The ICC represent the proportion of variation in the outcomes described at the barangay level and thus the degree of dependence. In the males, the estimated ICC for overweight and central adiposity were 0.18 (95% CI: 0.06–0.45) and 0.10 (95% CI: 0.01–0.46), respectively. For females, the respective estimated ICC were 0.05 (95% CI: 0.01–0.30) and 0.18 (95% CI: 0.05–0.46). Ignoring this statistical dependence could result in biased CI around parameter estimates. Additionally, the participants we analyzed started the study living in 33 barangays but now reside in 161 barangays, due to the 26% of this sample that has migrated within the study area between birth and young adulthood. The result is a heavily unbalanced dataset (which is problematic for a number of statistical methods) for which most barangays included in the analysis have fewer than 3 observations. To account for these issues, we employed generalized estimating equations (GEE) (26,27) with an exchangeable correlation structure. GEE is a method used to analyze clustered data, particularly when the dependent variable is binary. Like more commonly used multilevel models, GEE return more appropriate SE when data are clustered; however, GEE may return more reliable estimates when there are many small clusters (27).

Using GEE, we estimated the cross-sectional, population-averaged (i.e. marginal) effects of the independent variables measured at both the individual and community (barangay) levels. We began by estimating a series of gender-stratified models to estimate the unadjusted effect of each individual-level SES variable and community-level urbanicity on overweight or central adiposity, thus placing our research in the context of previous studies that investigated a single measure of SES. Nonlinearities in continuous variables were tested using quadratic terms and retained in the models when $P < 0.05$. We then estimated multivariable models that included all 4 individual-level SES variables and community-level urbanicity. We tested for multiplicative interactions among these variables, which were retained in the models when their respective Wald test P was <0.10 (or by likelihood ratio test with $P \leq 0.10$ for interactions involving categorical variables). All continuous variables were mean centered but left unstandardized to facilitate gender

TABLE 1 Sociodemographic and anthropometric characteristics of 987 male and 819 female young adults enrolled in the CLHNS[1]

	Females	Males
n	819	987
Age, *y*	21.5 ± 0.31	21.5 ± 0.30
Anthropometrics		
BMI, *kg/m²*	20.2 ± 3.2	21.0 ± 3.1*
Overweight (BMI ≥ 25), *%*	7.8	9.4
WC, *cm*	67.9 ± 7.5	72.2 ± 7.5*
Central adiposity,[2] *%*	6.5	6.1
Individual-level socioeconomic indicators		
Assets (range)	0.1 ± 2.8 (−3.4–15.7)	0.0 ± 2.9 (−3.3–16.0)
Income (100 PHP) (range)	5.9 ± 5.9 (0–40)	5.4 ± 5.9 (0–40)
Education, *%*		
No secondary school	7.9	20.7
Any secondary school	57.8	55.5
Any college	34.3	23.8*
Married, *%*	27.6*	19.0*
Urbanicity (range)	41.0 (8–61)	40.6 (8–61)
Barangay, *n*	127	136

[1] Values are means ± SD or %. *Different from females, $P < 0.05$ (*t* test or chi-square).
[2] Male WC >85 cm; female WC >80 cm.

comparisons. All reported *P*-values are 2-sided. The 95% CI for any reported proportions were calculated using the Wilson procedure (28,29). All statistical analyses were conducted using Stata version 10.0.

Results

Sample characteristics are reported in **Table 1**. Overall, the sample was young (mean age 21.5 y) and lean (mean BMI 20.2 and 21.0 for males and females, respectively). Overweight and/or central adiposity were found in 11% of the total sample compared with the 22.1% of the total sample classified as underweight (BMI <18.5). The distribution of income and assets were similar for males and females, although females were more likely to be college educated (34.3 vs. 23.8%) and married (27.6 vs. 19%) than males.

The patterns of associations among variables varied by gender but were similar when comparing outcome measures within gender, so we focused on describing the overweight (BMI ≥25) results. The results for males were similar to those in populations in other lower middle-income countries. Each of the SES indicators, as well as community-level urbanicity, was positively related to overweight in the unadjusted models (**Table 2**). In the multivariable model, only assets, marital status, and college education remained strong predictors of overweight. The relationship between assets and odds of overweight was particularly strong. A 1 SD increase over the mean assets score (SD, 2.96; total range, 19.4) was associated with a 64% increase in the odds of overweight [odds ratio (OR) 1.64 (95% CI: 1.26–2.13)].

Unlike the males, marital status was the only crude predictor of overweight in the females (**Table 3**). Though there was no discernable relationship between education and overweight in females [OR 0.82 (95% CI: 0.27–2.50)], it was notably the only SES indicator with a point estimate that suggested an inverse relationship.

An inhibitive interaction between urbanicity and assets emerged in the multivariable model for females (no other interactions were detected in either gender). This could be interpreted as a reduction in the positive effect of assets on overweight as urbanicity increases, or vise-versa. The difference in the estimated effect of assets on the odds of overweight at the ends of the observed urbanicity distribution was considerable. At the lowest observed level of urbanicity (8.0 points), a one-point increase in assets was associated with a 29% increase in the odds of overweight [OR 1.29 (95% CI: 1.01–1.65)] (**Fig. 1**); at the highest observed level of urbanicity (60.6 points), the same increase in assets was conversely associated with a 8% reduction in the odds of overweight [OR 0.92 (95% CI: 0.76–1.11)]. The ratio of these OR was 1.40 (95% CI: 0.97–2.03). We also explored the nature of this interaction by evaluating the prevalence of overweight in groups crudely defined by tertiles of assets and urbanicity (**Fig. 2**). Within the lower 2 tertiles of urbanicity, there was no clear relationship between assets and the prevalence of overweight. However, among women living in the most urban areas, there was an emerging trend for which the prevalence of overweight declined with increasing assets. The lowest prevalence of overweight in the entire sample was for highly urban women with high assets scores (<1%).

Discussion

We observed a pattern of relationships between SES and overweight and central adiposity that is consistent with studies from other countries with similar levels of economic development (11). Assets, income, and college education were all crude, positive predictors of overweight and central adiposity in males from our study. In the final multivariable model, assets were the

TABLE 2 Association of multiple socioeconomic indicators and urbanicity with overweight and central adiposity in 987 Filipino young adult males

	Male overweight (BMI ≥25 kg/m²)		Male central adiposity (WC >85 cm)	
	Unadjusted[1]	Adjusted[2]	Unadjusted[1]	Adjusted[2]
Individual level SES indicators	*OR (95% CI)*			
Assets	1.20 (1.13–1.28)	1.19 (1.08–1.30)	1.25 (1.17–1.34)	1.22 (1.10–1.35)
Income (100 PHP)	1.05 (1.02–1.08)	1.00 (0.96–1.04)	1.07 (1.04–1.10)	1.00 (0.96–1.04)
Any secondary school[3]	1.40 (0.71–2.75)	1.26 (0.62–2.56)	1.43 (0.59–3.51)	1.18 (0.46–2.99)
Any college[3]	3.33 (1.66–6.69)	2.22 (0.99–5.00)	4.57 (1.88–11.11)	2.37 (0.85–6.58)
Married	1.81 (1.12–2.94)	3.04 (1.76–5.25)	1.29 (0.70–2.42)	2.52 (1.26–5.07)
Urbanicity (10 pts)	1.22 (0.99–1.51)	1.06 (0.85–1.32)	1.25 (0.99–1.57)	1.06 (0.82–1.35)

[1] OR from unadjusted models estimate the crude relationship between the given independent and dependent variables.
[2] OR from the adjusted models estimate the relationship between the given independent and dependent variables, adjusted for all of the other independent variables.
[3] Referent group: no secondary school.

TABLE 3 Estimated impact of multiple socioeconomic indicators and urbanicity on overweight and central adiposity in 819 Filipino young adult females

	Female overweight (BMI ≥25 kg/m²)		Female central adiposity (WC >80 cm)	
	Unadjusted[1]	Adjusted[2]	Unadjusted[1]	Adjusted[2]
Individual level SES indicators		*OR (95% CI)*		
Assets	0.99 (0.91–1.08)	1.04 (0.93–1.17)	1.02 (0.93–1.12)	1.10 (0.97–1.24)
Income (100 PHP)	1.01 (0.97–1.05)	1.01 (0.97–1.06)	1.02 (0.98–1.06)	1.02 (0.97–1.07)
Any secondary school[3]	1.49 (0.53–4.21)	1.54 (0.53–4.44)	1.18 (0.42–3.32)	1.10 (0.38–3.20)
Any college[3]	0.82 (0.27–2.50)	0.85 (0.24–2.99)	0.56 (0.18–1.78)	0.50 (0.13–1.86)
Married	2.06 (1.21–3.50)	1.94 (1.11–3.41)	2.95 (1.64–5.31)	3.01 (1.62–5.60)
Urbanicity (10 pts)	1.20 (0.95–1.52)	1.19 (0.93–1.51)	1.27 (0.95–1.69)	1.28 (0.95–1.71)
Assets × urbanicity interaction	—	0.94 (0.87–1.01)	—	0.94 (0.87–1.01)

[1] OR from unadjusted models estimate the crude relationship between the given independent and dependent variables.
[2] OR from the adjusted models estimate the relationship between the given independent and dependent variables, adjusted for all of the other independent variables.
[3] Referent group: no secondary school.

most important predictor, overshadowing the estimated impact of income. This is probably because the assets score, which is derived from a principle components analysis of interviewer-observed indicators of assets and housing quality, was a more valid and/or reliable measure of wealth than income, which is based on respondent reports of multiple sources of household income. The estimated effect of college education was attenuated in the multivariable model but still positively related to overweight and central adiposity. Conversely, in the females, only marital status was a strong predictor of overweight and central adiposity. However, the multivariable models revealed an important interaction between assets and urbanicity. Among the most rural women, assets were positively related to overweight or central adiposity, whereas in the more urban areas, assets were not related to overweight or central adiposity. This interaction highlights the importance of investigating "more carefully the extent of interactions between characteristics of individuals [assets/SES] and the features of places [urbanicity] associated with varying health risks" (30).

Studies of the relationship between SES and obesity are beginning to produce important insights into rising obesity prevalence in lower- and middle-income countries. This body of research initially focused on socioeconomic disparities in obesity. In higher-income countries, SES tends to be inversely related to obesity, particularly among females (5,12). Conversely, in lower-income counties, it was once thought that obesity was only a problem for the affluent (5). However, a growing body of evidence suggests that the SES-obesity gradient is inversely shifting, becoming more like that in high-income countries. Furthermore, this shift seems to be occurring in women first and as a function of economic development (10,11).

The early focus on socioeconomic disparities in obesity was reinforced by the fact that most previous studies investigated single indicators of SES such as education or income, or composite scores that combined multiple indicators. This implies a "unitary view" (31) whereby SES (alternately social-class or socioeconomic position) is treated as an underlying construct that is similarly reflected in multiple, largely interchangeable measures (e.g. wealth, education). However, other research has indicated that individual indicators of SES may have varied, or even antagonistic, effects on obesity (6). A lack of studies considering the independent effects of multiple SES indicators was a key gap that we aimed to address.

Our results were consistent with studies that have examined the independent effects of multiple indicators of SES, particularly income and education, in lower- and middle-income countries. For example, a study of Brazilian adults living in 2 regions of the country that differed in level of economic development (13) found that the estimated effects of income and education varied as a function of both gender and region of residence. Income was a positive predictor of obesity (BMI ≥ 30 kg/m^2) in males living in both regions, whereas education was inversely associated with obesity in the more developed region. For females, income was positively related to obesity only in the less-developed region, whereas education was inversely related to obesity in both regions.

Given these observations from Brazil, it is notable that in our study, college education in females was the only SES indicator whose point estimate suggested an inverse relationship. Similar gender differences with regard to education have been recently reported in Asian populations in Thailand (32) and Korea (33). Furthermore, the interaction between assets and urbanicity in females also mimics the pattern seen in both Brazil and when comparing across countries, for which SES tends to be positively related to obesity in lower-income contexts and inversely associated with obesity in higher-income environments (10,11). To our knowledge, our study is the first time this pattern has been illustrated within a single contiguous study area.

Lastly, our research has helped confirm that the relationship between SES and body size is much more complicated than that suggested by previous studies that have focused on a single SES indicator. More studies of the independent effects of multiple

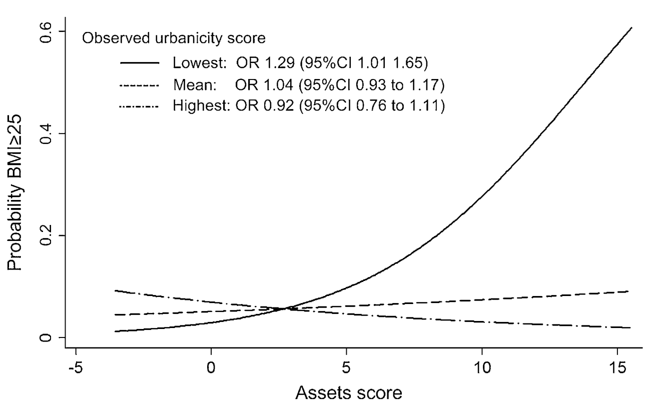

FIGURE 1 Model estimated effect of assets on the probability of overweight varies by level of urbanicity among 819 young adult Filipino females.

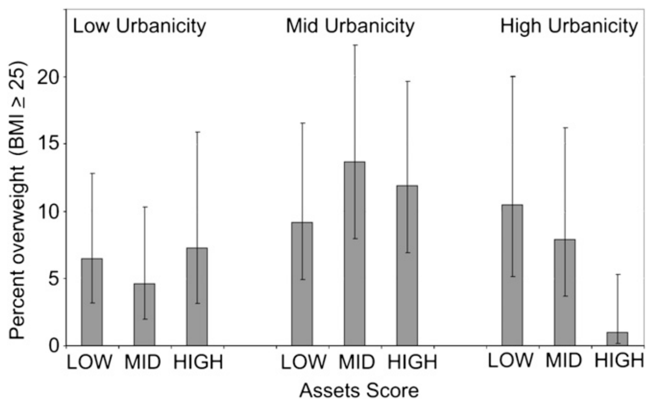

FIGURE 2 Prevalence of overweight (BMI ≥25 kg/m^2) by tertiles of urbanicity and assets among 819 young adult Filipino females. The 95% CI for proportions calculated using the Wilson procedure (29,30).

SES indicators are needed to help improve our understanding of the etiology of obesity in a transitioning society.

In conclusion, individual indicators of SES tended to be positively related to overweight and central adiposity in males and unrelated to overweight and central adiposity in females. However, once the modifying effects of urban residence were accounted for, assets were positively related to overweight and central adiposity among the most rural women, but not among more urban women. Though the prevalences of overweight and central adiposity are low in this sample of young adults, we observed a pattern of relationships that is consistent with countries further along in their economic transition. This suggests the public health impact of obesity will increase as the Philippines develops economically. Furthermore, public health intervention aimed at preventing obesity in the Philippines should not assume that higher SES populations are the primary target. Lastly, we recommend that future studies consider the independent effects of multiple SES indicators, particularly wealth and education, as well as interactions between these individual level characteristics with environmental features such as urbanicity.

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