Gender-Specific Associations of Objective and Perceived Neighborhood Characteristics With Body Mass Index and Waist Circumference Among Older Adults in the English Longitudinal Study of Ageing

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Objectives. We sought to determine whether objective and perceived neighborhood characteristics are independently associated with obesity indicators among older adults and whether associations differ by gender.

Methods. Linear regression was used to examine mutually adjusted associations of objective area-level neighborhood deprivation and perceived individual-level neighborhood disorder in 2002–2003 with body mass index (BMI) and waist circumference (WC) 2 years later among 6297 community-dwelling older adults in the English Longitudinal Study of Ageing.

Results. Associations between neighborhood characteristics and obesity indicators were evident for women only. Being in the most deprived quintile of neighborhood deprivation was associated with a BMI that was 1.18 kilograms per meters squared higher (95% confidence interval [CI] = 0.54, 1.83) and a WC that was 2.42 centimeters higher (95% CI = 0.90, 3.94) at follow-up in women after adjustment for baseline health status, socioeconomic factors, and neighborhood disorder. Neighborhood disorder was not independently associated with BMI or WC.

Conclusions. Among women, greater objective neighborhood deprivation was independently associated with higher BMI and WC after 2 years. Public efforts to reduce obesity among community-dwelling older women may benefit most from addressing objective residential characteristics, over and above subjective perceptions. (*Am J Public Health.* 2014;104:1279–1286. doi:10.2105/AJPH.2014.301947)

Obesity increases the risk of heart disease, type 2 diabetes, stroke, and some types of cancer,[1] making it an important condition to prevent and manage for any population. According to 2012 estimates, one third of men and women in England between 65 and 74 years of age are considered obese, the highest percentages of any age group.[2] Although in general, levels of obesity (as measured via body mass index [BMI]) decrease after the age of 75 years, levels of abdominal adiposity (as measured via waist circumference [WC]) continue to increase with advancing age, particularly among women.[2] With a 39% increase among individuals aged 65 to 84 years and a 106% increase among those older than 85 years expected from 2012 to 2032 in England alone,[3,4] it is increasingly important to build a broader understanding of obesity risk at older ages.

Obesity may be best understood within the context of its wider environmental influences.[5] Older adults may restrict much of their daily life activity to their residential environment, as a result of either retirement or functional limitations, and may consequently be more influenced by these surroundings than younger adults.[6] Thus, examining aspects of neighborhood environments may increase our understanding of obesity risk among older adults in particular.

Although definitions vary, a neighborhood is broadly regarded as the area immediately surrounding one's place of residence, measured either objectively at the area level through census data or predefined boundaries, or subjectively at the individual level through self-reported perceptions.[7] Objective neighborhood characteristics associated with an individual's obesity risk include residential density, walkability, presence of graffiti, local access to recreational facilities, presence of green space and supermarkets, and inadequate housing; unfavorable levels of these characteristics may together form a concept known as "neighborhood deprivation."[8,9] Associations between objective neighborhood factors and obesity risk have been shown to be gender-specific. For instance, one study showed that women living in the most deprived areas of the United Kingdom had a higher baseline BMI than those living in the least deprived areas and exhibited greater BMI increases over 13 years,[10] whereas these associations were not evident among men.

By contrast, subjective neighborhood characteristics may include individual perceptions of built attributes, interpersonal relationships, or safety. A subjective general construct known as "neighborhood disorder" aims to capture perceptions of both physical and social factors by incorporating dimensions such as safety, trust of neighbors, vandalism, and area cleanliness[11]; thus, this construct may include neighborhood characteristics that are particularly salient for the individual. Greater neighborhood disorder has been associated with higher levels of obesity indicators such as waist-to-hip ratio[11] and BMI.[12]

Despite the fact that both area-level objective and individual-level perceived aspects of neighborhoods demonstrate associations with obesity risk, the independence of these associations is unknown. Furthermore, their relevance to older populations and their gender-specific nature have not been established. Evidence also suggests that effects on obesity indicators may differ. For instance, objective neighborhood deprivation has been associated with higher BMI,[10] whereas subjective

neighborhood disorder has been associated with both higher BMI[12] and higher central adiposity.[11]

It would be useful to examine effects of neighborhood measures on separate indicators of obesity to understand which aspects are most strongly associated with obesity risk and, thus, the areas in which efforts to intervene would be best directed. In this study, involving a large sample of community-dwelling older adults in England, we sought to determine whether area-level objective neighborhood characteristics and individual-level subjective perceptions of the neighborhood environment are associated with obesity indicators independently of one another and whether these associations are gender-specific.

METHODS

The English Longitudinal Study of Ageing (ELSA) is a nationally representative panel study of individuals aged 50 years or older (born before March 1, 1952) living in private households in England. Participants are followed up every 2 years with a home-based nurse visit, including anthropometric measurements and blood sampling, carried out in alternate waves.[13] We used the first 2 waves of ELSA data in this study; baseline data (wave 1) were collected from 2002 to 2003, and follow-up data (wave 2) were collected 2 years later, from 2004 to 2005 (data from these waves were analyzed in 2013).

Wave 1 included a personal interview with all participants during which they were given a self-completion questionnaire. Core sample members (n = 11 391) were followed up 2 years later (wave 2). Individuals who completed the wave 2 interview in person (n = 8781; 82%) were then eligible for a nurse visit. Eighty-eight percent (n = 7666) of those interviewed in wave 2 completed the nurse visit and thereby had anthropometric measurements taken.[14]

Study Sample

Analyses were performed on participants with complete data on neighborhood measures, outcomes (BMI and WC), and covariates. The final sample included 6297 participants. Relative to participants who were included in the final sample, those who were excluded (n = 5095) were more likely to live in deprived areas ($P < .001$) and more likely to have a negative perception of their neighborhood ($P < .001$). In addition, those who were not interviewed in wave 2 were older, less healthy, and more socially disadvantaged than those who completed interviews.[14] Dropout at the wave 2 nurse visit was associated with being more socially disadvantaged, with worse physical health, and with poorer health behaviors.[14]

Neighborhood Measures

The Index of Multiple Deprivation (IMD), an area-level measure combining indexes of local deprivation across all of the regions of England, was used to measure objective neighborhood deprivation. The IMD gathers data from small geographical units consisting of approximately 1500 people each.[15] Thirty-seven indicators of disadvantage based on administrative and census data were aggregated via standardization and weighting techniques to capture 7 conceptual dimensions of area-level deprivation: income, employment, health deprivation and disability (years of potential life lost, illness and disability ratios, and physical and mental health based on data on hospital admissions, health benefits, and suicides), education, skills and training, housing, and geographical access to services.[15]

The validity of the IMD has been described elsewhere.[16] We used the 2004 version of the index because it corresponded to the time period following the first ELSA wave in 2002. Index values were grouped into quintiles ranging from least deprived to most deprived.

Subjective neighborhood disorder was measured via responses to a 9-item semantic differential scale on the wave 1 self-completion questionnaire. Participants were asked, "How do you feel about your local area, that is, everywhere within a 20-minute walk or about a mile of your home?" Statements included:

"I really feel part of this area,"
"Vandalism and graffiti are a big problem in this area,"
"I often feel lonely living in this area,"
"Most people in this area can be trusted,"
"People would be afraid to walk alone in this area after dark,"
"Most people in this area are friendly,"
"People in this area will take advantage of you,"
"This area is kept very clean," and
"If you were in trouble, there are lots of people in this area who would help you."

A corresponding opposing statement (i.e., 'I feel that I don't belong in this area') anchored the opposite end of each 7-point scale. Together, these items aimed to capture the extent to which participants were attached to their neighborhood, trusted their neighbors, perceived that the neighborhood was safe, and perceived the neighborhood as attractive.

These items were originally developed through cognitive piloting techniques and were validated as part of a larger study of area-level variations in health,[17] with some items used in a previous study focusing on obesity.[11] Responses were appropriately recoded, summed, and grouped into quintiles ranging from least perceived disorder (most positive neighborhood perceptions) to most perceived disorder (most negative neighborhood perceptions). The measure was found to have acceptable internal reliability (Cronbach $\alpha = 0.77$).

Obesity Indicators

Trained nurses conducted objective anthropometric measurements during the wave 2 visit. Tanita electronic scales were used to measure body weight (without shoes and in light clothing), and a stadiometer was used to measure height.[14] BMI was calculated via the standard formula (weight in kilograms divided by the square of height in meters). Measuring tape was used to record WC twice midway between the iliac crest and lower rib. The average of the first 2 measurements was used if they differed by no more than 3 centimeters; otherwise, a third reading was taken and the 2 most similar results used.[14]

Covariates

Gender and age were recorded from household grids and later confirmed with the individual questionnaires.[18] Limiting long-standing illness (yes or no) was based on whether participants reported having a long-standing illness and, if so, whether it limited their activities.[19] Responses to the 8-item Center for Epidemiological Studies Depression Scale, which has been validated[20,21] and used previously in ELSA,[22] were used to assess depressive symptoms.

Educational level was based on the highest formal educational qualification completed[18]: degree or higher education, intermediate (equivalent to completing high school), or no formal qualifications. The 5-item National Statistics Socio-economic Classification[18] was used to determine occupational class on the basis of participants' most recent full-time occupation (managerial or professional, intermediate, small employer or self-employed, lower supervisory or technical, semi-routine, or other). Marital status and cohabitation were considered jointly as married or cohabiting versus single, separated, divorced, or widowed. The number of years lived at the current address, representing the amount of time the participant had resided in the same neighborhood, was recorded at baseline.

Three questions on frequency of participation in mild, moderate, and vigorous activities (more than once per week, once per week, 1 to 3 times per month, hardly ever or never) were used to gather information on self-reported physical activity. Before answering, participants were shown examples of physical activities on a card to help them interpret different activity intensities. Examples of mild activities included doing laundry and engaging in home repairs; moderate-intensity activities included gardening and walking at a moderate pace, and vigorous intensity included running or jogging and aerobic workouts. Physical activity level was further categorized into 3 groups (as previously described[23]): inactive (no activity on a weekly basis) or only mild activity at least once a week, at least moderate but no vigorous activity once or more a week, or any vigorous activity once or more a week.

Alcohol consumption was based on international guidelines of 21 units per week for men and 14 units per week for women; participants were grouped into 2 categories (drinks within weekly recommended limits or drinks over weekly recommended limits).[24,25] Participants were also grouped into 2 categories with respect to smoking status (nonsmoker or ex-smoker vs current smoker).[25]

Statistical Analyses

Given that objective deprivation was measured via links to administrative data and census outputs involving approximately 1500 people per area unit,[15,16] the number of people representing each area in the final sample was small. Less than 2% of the sample was selected from the same local authority, and in most cases the figure was less than 1%. Because the potential for clustering at this level is small, we deemed multilevel modeling unsuitable and instead performed linear regressions to examine associations of objective and perceived neighborhood characteristics with BMI and WC. After testing interactions between neighborhood measures and gender in relation to BMI and WC, we analyzed data separately for men and women.

In the first model, BMI was regressed on objective neighborhood deprivation after adjustment for age. Baseline health factors, socioeconomic factors, number of years lived at current address, and health behaviors were added in the second model, with subjective neighborhood disorder added last to examine whether the 2 neighborhood measures were associated with BMI independently. Similar models were run for WC and for perceived neighborhood disorder with respect to BMI and WC.

We conducted sensitivity analyses with a sample excluding BMI and WC values 3 standard deviations above and below the mean, to assess whether associations were influenced by extreme values, and with a sample excluding people who reported changing addresses between baseline and follow-up, to assess whether associations were influenced by neighborhood familiarity. SPSS version 17.0 (SPSS Inc, Chicago, IL) was used in performing the analyses, with $P < .05$ signifying statistical significance.

RESULTS

The final sample was 45.7% male, with a mean age of 63.4 years (SD = 9.3). As can be seen in Table 1, approximately 30% of men and women reported having a limiting longstanding illness, and 82.1% of men and 66% of women were either married or cohabiting. In addition, 41.8% of men and 26.4% of women were in the highest occupational category, whereas 22.6% and 35.5%, respectively, were in the lowest category. Nearly 15% of men and 20.3% of women were sedentary or had low physical activity levels. More than 17% of men reported having consumed alcohol over the recommended weekly limit (as compared with 10% of women), and approximately 16% of both men and women were current smokers.

Approximately 75% of men and 70% of women were overweight or obese (BMI of ≥ 25 kg/m^2), and approximately 46% and 56%, respectively, had a high-risk WC (≥ 102 cm for men and ≥ 88 cm for women). A total of 26.5% of men and 25.3% of women were in the lowest (least deprived) neighborhood deprivation quintile, whereas 11.0% of men and 12.1% of women were in the highest quintile.

Neighborhood Characteristics and Body Mass Index

A significant interaction between objective deprivation and gender in relation to BMI was observed ($P < .001$). As shown in Table 2, being in the most deprived (vs least deprived) quintile of objective deprivation was not associated with a higher BMI among men (b = 0.45; 95% confidence interval [CI] = −0.10, 1.00); among women, however, it was associated with a BMI that was 1.92 kilograms per meters squared higher (95% CI = 1.30, 2.53) after adjustment for age. Greater objective neighborhood deprivation remained significantly associated with a higher BMI in women after consideration of baseline health status, socioeconomic factors, number of years lived at current address, and health behaviors (b = 1.22; 95% CI = 0.59, 1.86); in addition, it was associated with a BMI that was 1.18 kilograms per meters squared higher (95% CI = 0.54, 1.83) when subjective perceptions were included in the model.

An interaction term for perceived disorder and gender in relation to BMI was not significant ($P = .1$). Being in the highest quintile of neighborhood disorder was not associated with a higher BMI for men or women after adjustment for age. Also, being in the highest quintile of perceived disorder was not associated with BMI after adjustment for baseline health, socioeconomic factors, years lived at current address, and health behaviors (men: b = −0.15; 95% CI = −0.66, 0.35; women: b = 0.12; 95% CI = −0.44, 0.69). Nor was there an association after the addition of objective deprivation to the model (men: b = −0.16; 95% CI = −0.67, 0.35; women: b = −0.04; 95% CI = −0.61, 0.54).

Neighborhood Characteristics and Waist Circumference

A significant interaction between objective deprivation and gender in relation to WC was observed ($P = .01$). As shown in Table 3, being in the most deprived (vs least deprived) quintile of objective deprivation was associated with a WC that was 2.15 centimeters higher (95% CI = 0.68, 3.62) among men and a WC that was 4.52 centimeters higher (95% CI = 3.07, 5.97) among women after adjustment for age. Being in the highest quintile of objective deprivation was not associated with a higher WC in men after adjustment for baseline health, socioeconomic factors, years lived at current address, and health behaviors (b = 1.28; 95% CI = –0.27, 2.84); however, it was associated with a WC that was 2.59 centimeters higher (95% CI = 1.09, 4.09) among women after the same covariates had been taken into account. This association remained significant among women after adjustment for subjective perceptions (b = 2.42; 95% CI = 0.90, 3.94).

The interaction term for perceived disorder and gender in relation to WC was not significant ($P = .15$). Although being in the highest neighborhood disorder quintile was not associated with a higher WC in men (b = 0.29; 95% CI = –1.07, 1.64), it was associated with a WC that was 1.76 centimeters higher (95% CI = 0.42, 3.10) in women after adjustment for age. This association among women became nonsignificant after consideration of baseline health status, socioeconomic factors, years lived at current address, and health behaviors (b = 0.89; 95% CI = –0.44, 2.22) and remained nonsignificant when objective deprivation was included in the model (b = 0.57; 95% CI = –0.78, 1.92).

The pattern of results did not substantively change when analyses were repeated after excluding participants with BMI and WC values that were 3 standard deviations above and below the sample mean or after excluding those who reported changing their home address between baseline and follow-up (data available on request).

DISCUSSION

Our goals in this study were to prospectively determine whether objective and perceived neighborhood characteristics are

TABLE 1—Sample Characteristics at Baseline, by Gender: English Longitudinal Study of Ageing, 2002–2005

Characteristic	Men (n = 2880), Mean ±SD or No. (%)	Women (n = 3417), Mean ±SD or No. (%)
Age, y	63.4 ±9.1	63.4 ±9.4
50–59	1188 (41.3)	1426 (41.7)
60–69	947 (32.9)	1078 (31.5)
70–79	592 (20.6)	689 (20.2)
80–89	147 (5.1)	215 (6.3)
90–99	6 (0.2)	9 (0.3)
Occupational category		
Managerial or professional	1205 (41.8)	902 (26.4)
Intermediate	160 (5.6)	745 (21.8)
Small employer/self-employed	409 (14.2)	268 (7.8)
Lower supervisory or technical	448 (15.6)	220 (6.4)
Semi-routine	650 (22.6)	1212 (35.5)
Other	8 (0.3)	70 (2.0)
Limiting long-standing illness	835 (29.0)	1037 (30.3)
Married or cohabiting	2365 (82.1)	2256 (66.0)
No formal educational qualifications	844 (29.3)	1344 (39.3)
Sedentary/low physical activity	428 (14.9)	693 (20.3)
Alcohol consumption above weekly recommended limit	505 (17.5)	342 (10.0)
Current smoker	463 (16.1)	560 (16.4)
Total depression score	1.1 ±1.6	1.6 ±1.9
Body mass index[a]	27.8 ±4.2	27.9 ±5.3
Underweight (< 18.5 kg/m^2)	17 (0.6)	38 (1.1)
Normal weight (18.5–24.9 kg/m^2)	690 (24.0)	1035 (30.3)
Overweight (25–29.9 kg/m^2)	1425 (49.5)	1312 (38.4)
Obese (≥ 30 kg/m^2)	748 (26.0)	1032 (30.2)
Waist circumference[a]	101.3 ±11.2	90.6 ±12.4
High-risk waist circumference[b]	1313 (45.6)	1900 (55.6)
Years lived at current address	20.7 ±13.5	20.7 ±14.1
Living at same address at follow-up[a]	2754 (95.6)	3245 (95.0)
Objective neighborhood deprivation quintile		
1st (least deprived)	764 (26.5)	863 (25.3)
2nd	729 (25.3)	857 (25.1)
3rd	579 (20.1)	702 (20.5)
4th	491 (17.0)	582 (17.0)
5th (most deprived)	317 (11.0)	413 (12.1)
Perceived neighborhood disorder quintile		
1st (lowest disorder level)	492 (17.1)	684 (20.0)
2nd	546 (19.0)	652 (19.1)
3rd	632 (21.9)	731 (21.4)
4th	625 (21.7)	696 (20.4)
5th (highest disorder level)	585 (20.3)	654 (19.1)

[a]Measured at follow-up (wave 2).
[b]≥ 102 cm for men and ≥ 88 cm for women.

TABLE 2—Gender-Specific Associations of Objective Neighborhood Deprivation and Perceived Neighborhood Disorder With Body Mass Index at Follow-Up: English Longitudinal Study of Ageing, 2002–2005

Variable	Men (n = 2880), BMI at Follow-Up			Women (n = 3417), BMI at Follow-Up		
	Model 1,[a] b (95% CI)	Model 2,[b] b (95% CI)	Model 3,[c] b (95% CI)	Model 1,[a] b (95% CI)	Model 2,[b] b (95% CI)	Model 3,[c] b (95% CI)
Objective neighborhood deprivation quintile at baseline						
1st (least deprived; Ref)	0.00	0.00	0.00	0.00	0.00	0.00
2nd	0.44 (0.02, 0.87)	0.37 (−0.05, 0.78)	0.36 (−0.06, 0.78)	0.67 (0.17, 1.17)	0.58 (0.09, 1.07)	0.57 (0.08, 1.06)
3rd	0.35 (−0.10, 0.81)	0.28 (−0.17, 0.72)	0.26 (−0.19, 0.71)	0.71 (0.18, 1.23)	0.50 (−0.01, 1.02)	0.49 (−0.03, 1.01)
4th	0.40 (−0.07, 0.88)	0.29 (−0.20, 0.77)	0.28 (−0.21, 0.77)	1.24 (0.68, 1.79)	0.90 (0.35, 1.45)	0.87 (0.31, 1.42)
5th (most deprived)	0.45 (−0.10, 1.00)	0.25 (−0.33, 0.82)	0.24 (−0.35, 0.82)	1.92 (1.30, 2.53)	1.22 (0.59, 1.86)	1.18 (0.54. 1.83)
Perceived neighborhood disorder quintile at baseline						
1st (lowest disorder level; Ref)	0.00	0.00	0.00	0.00	0.00	0.00
2nd	−0.41 (−0.92, 0.10)	−0.44 (−0.94, 0.06)	−0.43 (−0.93, 0.07)	−0.53 (−1.10, 0.04)	−0.45 (−1.00, 0.10)	−0.44 (−0.99, 0.11)
3rd	−0.17 (−0.66, 0.32)	−0.21 (−0.69, 0.28)	−0.20 (−0.68, 0.29)	−0.02 (−0.57, 0.53)	0.05 (−0.49, 0.59)	0.00 (−0.53, 0.54)
4th	−0.05 (−0.54, 0.45)	−0.20 (−0.69, 0.28)	−0.20 (−0.69, 0.29)	0.21 (−0.35, 0.77)	0.13 (−0.42, 0.67)	0.04 (−0.51, 0.59)
5th (highest disorder level)	−0.02 (−0.52, 0.49)	−0.15 (−0.66, 0.35)	−0.16 (−0.67, 0.35)	0.47 (−0.10, 1.04)	0.12 (−0.44, 0.69)	−0.04 (−0.61, 0.54)

Note. BMI = body mass index; CI = confidence interval.
[a]Adjusted for age.
[b]In addition to age, adjusted for limiting long-standing illness, depressive symptoms, educational level, occupational class, marital status, number of years lived at current address, physical activity, alcohol consumption, and smoking status.
[c]Mutually adjusted for alternative neighborhood measure (subjective disorder or objective deprivation) in addition to variables adjusted for in model 2. $P < .001$ for interaction between objective deprivation and gender. $P = .1$ for interaction between subjective disorder and gender.

independently associated with obesity indicators among community-dwelling older adults and whether these associations are gender-specific. The key findings were that greater objective neighborhood deprivation, but not perceived disorder, was independently associated with higher BMI and WC and that these associations were evident among women only. Associations between neighborhood deprivation and obesity indicators are thus not likely explained by subjective neighborhood perceptions.

Previous studies have considered objective and perceived characteristics separately; they have not, to our knowledge, been examined in the same model. The IMD is an area-level measure capturing objective characteristics such as education, training, housing, and access to services, whereas neighborhood disorder is an individual-level measure capturing perceptions of physical environmental attributes along with the social constructs of interpersonal trust, social cohesion, and area attractiveness. Thus, rather than being seen as a subjective version of the IMD, neighborhood disorder can be viewed as a complementary measure capturing a broad combination of physical and social neighborhood characteristics that may be particularly salient for individuals.

Higher levels of objectively measured neighborhood deprivation were associated with a higher BMI among women only, after adjustment for individual-level socioeconomic factors, supporting gender-specific results from previous cross-sectional and prospective research.[10,26] Our study builds on these findings by suggesting that associations among women persist after baseline physical and mental health status has been taken into account and that objective deprivation remains associated with obesity indicators independently of subjective perceptions of neighborhood factors. Furthermore, our analyses indicate that associations are evident for WC as well, supporting the relevance of objective area-level deprivation to the risk of both overall obesity and central obesity among older women.

The gender-specific nature of these associations may stem from differences in degree of exposure to adverse neighborhood characteristics. For instance, the women in our aging cohort may have spent more time in and around their homes, as a result of either lower participation in full-time employment or greater caregiving responsibilities.[27] Women also tend to experience higher morbidity and lower mortality than men,[28] which may result in their accumulating greater exposure to residential environments with advancing age.

By contrast, we found that negative neighborhood perceptions were not associated with a higher BMI but were associated with a higher WC in women after adjustment for age (although not after consideration of baseline socioeconomic and health status). Together, these results suggest that objective factors may be more relevant for the neighborhood–obesity relationship among older women in particular, whereas the effects of subjective perceptions may be explained by personal socioeconomic and health factors.

Several of the area-level factors forming our deprivation measure, such as poor housing quality[29] and local access to health services,[8,30] have previously demonstrated associations with obesity and may thus be appropriate targets for interventions. Neighborhood environments may influence obesity risk in part by structuring relevant health behaviors.[31] For

TABLE 3—Gender-Specific Associations of Objective Neighborhood Deprivation and Perceived Neighborhood Disorder With Waist Circumference at Follow-Up: English Longitudinal Study of Ageing, 2002–2005

Variable	Men (n = 2880), WC at Follow-Up			Women (n = 3417), WC at Follow-Up		
	Model 1,[a] b (95% CI)	Model 2,[b] b (95% CI)	Model 3,[c] b (95% CI)	Model 1,[a] b (95% CI)	Model 2,[b] b (95% CI)	Model 3,[c] b (95% CI)
Objective neighborhood deprivation quintile at baseline						
1st (least deprived; Ref)	0.00	0.00	0.00	0.00	0.00	0.00
2nd	1.14 (0.00, 2.28)	0.93 (−0.20, 2.05)	0.91 (−0.22, 2.03)	1.24 (0.07, 2.40)	0.95 (−0.20, 2.09)	0.94 (−0.21, 2.08)
3rd	0.77 (−0.45, 1.98)	0.49 (−0.72, 1.70)	0.40 (−0.82, 1.61)	1.27 (0.04, 2.50)	0.74 (−0.48, 1.95)	0.69 (−0.52, 1.91)
4th	1.10 (−0.17, 2.38)	0.59 (−0.72, 1.90)	0.54 (−0.78, 1.86)	2.47 (1.17, 3.76)	1.53 (0.23, 2.83)	1.41 (0.10, 2.72)
5th (most deprived)	2.15 (0.68, 3.62)	1.28 (−0.27, 2.84)	1.21 (−0.36, 2.79)	4.52 (3.07, 5.97)	2.59 (1.09, 4.09)	2.42 (0.90, 3.94)
Perceived neighborhood disorder quintile at baseline						
1st (lowest disorder level; Ref)	0.00	0.00	0.00	0.00	0.00	0.00
2nd	−0.91 (−2.28, 0.46)	−0.94 (−2.29, 0.41)	−0.93 (−2.28, 0.42)	−0.69 (−2.02, 0.64)	−0.54 (−1.83, 0.76)	−0.52 (−1.82, 0.77)
3rd	−0.61 (−1.94, 0.72)	−0.71 (−2.01, 0.60)	−0.71 (−2.01, 0.60)	0.25 (−1.05, 1.54)	0.34 (−0.92, 1.61)	0.25 (−1.02, 1.51)
4th	0.66 (−0.67, 1.99)	0.26 (−1.05, 1.57)	0.25 (−1.06, 1.57)	0.67 (−0.65, 1.98)	0.40 (−0.89, 1.68)	0.23 (−1.06, 1.52)
5th (highest disorder level)	0.29 (−1.07, 1.64)	−0.14 (−1.49, 1.21)	−0.22 (−1.60, 1.15)	1.76 (0.42, 3.10)	0.89 (−0.44, 2.22)	0.57 (−0.78, 1.92)

Note. CI = confidence interval; WC = waist circumference.
[a]Adjusted for age.
[b]In addition to age, adjusted for limiting long-standing illness, depressive symptoms, educational level, occupational class, marital status, number of years lived at current address, physical activity, alcohol consumption, and smoking status.
[c]Mutually adjusted for alternative neighborhood measure (subjective disorder or objective deprivation) in addition to variables adjusted for in model 2. $P = .01$ for interaction between objective deprivation and gender. $P = .15$ for interaction between subjective disorder and gender.

example, decreased availability or affordability of healthy food or living within close proximity to stores selling calorie-dense foods may promote a high-calorie diet and weight gain.[32–35] Neighborhoods may also influence energy expenditure through either presenting or preventing opportunities to engage in physical activity.[9,33,34,36,37] Physical environments have demonstrated weak and inconsistent associations with physical activity among older adults[38]; however, social aspects including perceived social support and social cohesion have been shown to promote physical activity.[39,40]

In our study, associations between objective deprivation and obesity indicators remained after health behaviors had been taken into account, which may either highlight the difficulty in measuring such behaviors or suggest the involvement of other mediating factors. For example, living in an environment perceived to be disordered or threatening may increase one's risk of general or central obesity through the triggering of stress-related physiological pathways.[11,12] Stress has also been associated with consumption of energy-dense comfort foods.[41,42] Detailed mediation analyses are required to clarify these mechanisms. With respect to obesity indicators, effect sizes for objective and perceived neighborhood measures were small in magnitude, as might be expected in an examination of contextual associations. However, because these environmental exposures have been hypothesized to influence patterns of diet and physical activity[11] and trigger psychosocial stress responses,[12] their indirect effects may strengthen as neighborhood environments become more predominant in later life.

Strengths and Limitations

This study benefited from a large sample of community-dwelling older adults in England. Objective and perceived neighborhood measures and objectively measured total body and abdominal obesity indicators were examined in conjunction, and together they captured a wider range of influence than previously considered for this age group. Physical illness and mental illness at baseline, which are both limiting and highly prevalent in older populations but have been excluded in several previous studies, were also taken into account.[43,44] Participants included in the final sample were relatively healthy and socially advantaged in comparison with those who were excluded. Thus, we may not have fully captured the most deprived people in the population (as reflected in the smaller number of participants in the most deprived IMD quintile), those who perceived their neighborhood most negatively, or, indeed, those with poorer health profiles. As a result, any associations observed likely underestimate true effects for the most deprived or least healthy individuals in the general population.

Indirect measures of obesity, such as BMI, can be difficult to interpret because they incorporate body fat and lean mass, which may vary substantially in older populations. Data on neighborhood measures were gathered at different times; however, because 95.3% of the sample reported living at the same address in wave 2 as in wave 1, the IMD data likely remained unchanged in the case of most of the participants between 2002 and 2004. Finally, health behaviors were self-reported, potentially introducing measurement error.

Conclusions

Our results support gender-specific associations of residential deprivation with obesity risk extending beyond the scope of individual circumstances and subjective neighborhood perceptions, with associations evident for women only. Wider ecological factors may play an important role in determining the risk of obesity, and our evidence suggests that neighborhoods may indeed be a relevant set of environmental exposures for older women in particular. Public efforts to reduce the burden of obesity among community-dwelling older women may benefit most from an area-level approach addressing objective residential conditions, such as housing quality and local access to services, over and above subjective perceptions. ■

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Contributors

J. A. Bell wrote the first draft of the article. M. Hamer and A. Shankar critically reviewed the article. All of the authors contributed to the study design, analysis, and interpretation of data.

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Human Participant Protection

This study was approved by the London Multi-Centre Research Ethics Committee. Participants provided written informed consent.

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