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ORIGINAL ARTICLE

Examining the connection between residential histories and obesity among Ghanaians: evidence from a national survey

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Abstract

Background This paper examined the connection between residential histories and obesity in Ghana. In the last two decades, low- and middle-income countries (LMICs) have witnessed the fastest growth in obesity incidence. These obesity trends in many LMICs including Ghana are associated with rapid economic growth and urbanisation. Features of the urban food and built environments contribute to obesity in LMICs in many ways, including exposure to unhealthy foods, sedentary lifestyles, and passive transportation.

Methods The analytical sample consisted of 4368 adults (aged 18 and above) drawn from the World Health Organisation's Study on Global Ageing and Health in Ghana. We employed descriptive statistics and multivariate regression models to examine the relationship between residential histories and obesity in later life using STATA 14.

Results Significant differences were observed among respondents, based on their childhood and adult residential histories. For instance, 44% of respondents who spent their childhood and adult life in the same urban area were obese, compared to 18% of those who spent their childhood and adulthood in the same rural area. Multivariable analysis revealed that cumulative exposure to urban environment was significantly associated with obesity. For example, respondents who spent their childhood and adulthood in different urban areas and childhood and adulthood in the same urban area were significantly more likely to be obese than respondents who lived in rural areas during childhood and adulthood (OR = 2.37, $p < 0.001$ and OR = 1.44, $p < 0.001$, respectively).

Conclusion Our findings show that urban residence during childhood and later in life may present cumulative risks for adult obesity. Locally appropriate public health strategies that encourage healthy lifestyles among urban dwellers will be critical in the fight against obesity.

Keywords Obesity · Place of residence · Residential mobility · Ghana

Introduction

Obesity has been described as one of the greatest public health concerns of the modern era. The World Health Organization (WHO) indicates that global prevalence of obesity has reached epidemic proportions. It is estimated that over 650 million adults (aged 18 years and over) in the world are obese (WHO 2017). Although current evidence suggest that obesity is more prevalent in developed countries, the proportions recorded in low- and middle-income countries (LMICs) are equally alarming (Mendez et al. 2009). According to some studies, the prevalence of obesity in LMICs has tripled in just two decades, compared to a two-fold growth observed globally between 1980 and 2008 (Alwan 2011; Shimpton and Rokx 2012).

Sub-Saharan African (SSA) countries present classical examples of LMICs with an increasing burden of obesity. In a region where underweight and related sequelae has been the predominant malnutrition challenge (WHO 2017), the unprecedented surge in the incidence of overweight and obesity cases posits significant threats to the already burdened health care systems (Micklesfield et al. 2013). For instance, there is

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evidence that chronic disease management strategies are hampered by an inadequate human resource to rollout programs needed by patients (Bischoff et al. 2009). Such developments are worrisome because available evidence suggest that 27 out of 32 SSA countries have an overweight prevalence greater than 10%, among which seven countries have a higher than 10% prevalence of obesity (Neupane et al. 2016).

Obesity as a major risk factor for many non-communicable diseases (NCDs) is well established. Many reports have cited increased incidences of hypertension, stroke, diabetes mellitus, cancers, and other NCDs in populations characterized with rising prevalence of overweight and obesity(WHO 2014a). Although NCDs are not the leading causes of mortality and disability in SSA (Mensah 2015), they are increasingly becoming key determinants of poor health outcomes in the region (Abubakari et al. 2008; Mayosi et al. 2009; Ziraba et al. 2009). In 2013, for instance, all NCDs accounted for almost a third of the deaths in SSA (Naghavi et al. 2015), with obesity-related cardiovascular diseases constituting 38.8% of these deaths (Mensah 2015).

Beyond the simplistic physiological etiology of energy imbalance, extant literature depicts obesity as a complex multifactorial condition with diverse determinants between population groups and across the life course (Butland et al. 2007). These include, but are not limited to genetics; individual psychology, dietary behaviors, societal influences, and physical environmental factors also contribute (Popkin and Larsen 2004; Butland et al. 2007; Popkin et al. 2012). In SSA, research on adult obesity determinants has been theorized around the influence of a person's socio-demographic environment to the energy-balance equation (Ziraba et al. 2009; Scott et al. 2012; Madise and Letamo 2017). Comparable to other settings, aging, being female, and various socio-cultural orientations have been found to be significant predictors of obesity (Mbochi et al. 2012; Kandala and Stranges 2014). However, peculiar to the SSA setting, many authors have reported obesity to be the preserve for socio-economic elites, with an average overweight/obese individual associated with being wealthy, educated, white-collar worker, and residing in an urban setting (Ziraba et al. 2009; Agyemang et al. 2016; Neupane et al. 2016). Although these findings have made significant contributions, the substantial focus on a person's present circumstances may only present a partial picture of the obesity phenomenon in SSA.

Recently, there is a growing body of literature that links childhood circumstances and adult obesity through various complex pathways (Kestilä et al. 2009; Angkurawaranon et al. 2015). For instance, evidence has shown that early undernourishment at critical infancy stages can lead to adult obesity in instances where such children grow up in obesogenic environments — via the phenomenon of metabolic programming (Whitaker and Dietz 1998; Shimpton and Rokx 2012). However, the effect of metabolic programming has been found to be common among Asian communities and hence, on its own, may not offer sufficient explanation for the obesity pandemic among the African population (Shimpton and Rokx 2012). A more realistic life course pathway may demonstrate the impact of both childhood and adult social and built environment on adult obesity. Such an approach takes into account residential mobility between urban and non-urban locations, which has been found to impact weight gain and obesity (Jones 2015). Studies have also shown that factors related to underprivileged socio-economic childhood circumstances including lower parental educational attainment, inadequate household income, and disadvantaged area of residence increase risk of obesity in later life (Gonzalez et al. 2012).

A major limitation in the literature is that the majority of studies examining the relationship between childhood circumstances and obesity emanate from developed countries, creating a gap in knowledge about the situation in LMICs, including Ghana. Additionally, findings on the extent to which present circumstances mediate relationship between childhood residential histories and obesity remain inconsistent (Kestilä et al. 2009). This study makes a contribution to the literature by examining the relationship between residential mobility histories and obesity in later life, using nationally representative data from Ghana.

Linking development context and urban environments with nutrition and health

Since the onset of the industrial revolution, mankind has witnessed unprecedented shifts in population dynamics that have affected lifestyle and health outcomes (Popkin 2001). With the understanding that populations evolve in patterns, scientists have conceptualized two major transition processes that explain these shifts: the demographic transition — moving from a period of high births and deaths to a period of low births and deaths in response to socio-economic development (McCracken and Phillips 2017) — and the epidemiologic transition — describing the patterns of disease burden, transforming from an era of prevalent infectious diseases to an era dominated by chronic and degenerative diseases (Omran 2005). However, scientists have recently recognized the equally important nutritional changes preceding or occurring concurrently with these two transitions (Popkin 2001). The nutrition transition, espoused by Barry Popkin in 1993, describes the changes in dietary patterns that have occurred across time and space (Popkin 1993), more so with regard to the overall diet structure and composition (Popkin 2001).

In the context of developing countries, Popkin describes the nutrition transition as a move from traditional foods to 'Western' forms of diet. As societies continues to modernize, dietary patterns seem to be synchronizing, and

populations are more likely to adopt processed energy-dense foods, rich in saturated fats, sugars, and animal-sourced proteins (Popkin 1993). This globalization of food culture is occurring more rapidly in urban areas at the peril of traditional diets, typically characterized with staples rich in carbohydrates, fibre, and plant proteins (Vorster et al. 1999; Popkin 2002a; Steyn and Mchiza 2014). Although traditional foods lack diversity, they are deemed to be quality diets, capable of providing adequate nutrients that support normal growth, and lowering the risk of nutrition-related diseases and conditions including obesity (Delisle et al. 2013). Thus, the progressive supplanting of traditional diet signals that the impact of nutrition transition on the population's health is largely negative, as opposed to the other transition processes (Delisle et al. 2013).

Similarly to other transition processes, nutrition transition is spatially heterogeneous (Ervin et al. 2013). At any given time, population units in the same region or country might be at dissimilar stages of the transition (Abrahams et al. 2011). Overall, the majority of developed countries are thought to be in the final stage whereas developing countries are on either the third or fourth stages (Popkin 2002b). As such, within developing countries, while populations in rural areas may be characterised by receding famines and appropriate energy consumption–expenditure balance, their counterparts in urban areas may be associated with energy-dense diets and increasing sedentary lifestyles. Due to these variations in the nutrition transition across spatial contexts, related health outcomes including prevalence of NCDs and obesity are expected to differ between rural and urban areas. In addition to evidence suggesting that low-income countries are more vulnerable to nutrition-related NCDs, WHO indicates that the proportion of young people affected with NCDs in the developing world are much higher as compared to developed countries (WHO 2014b). This is attributable to nutrition transition occurring rapidly in developing countries (Popkin 2002b) due to accelerated levels of urbanization (Vorster et al. 1999).

The most apparent expression of nutrition transition in SSA is rising obesity prevalence in the adult population. This is even more visible in many urban settings, where the prevalence of obesity is higher than the national prevalence. Concurrently, hypertension has also been the most common obesity-related NCD that has increased in the region. Age-standardized estimates from WHO report that at a prevalence of 46% among adults of 25 years and over, the African region has the highest prevalence of hypertension in the world, despite a modest slump of hypertension levels worldwide (WHO 2014b). Evidence has also shown that obesity accounts to a great extent for the growing cases in SSA (Niakara et al. 2007; Addo et al. 2008), even though it is thought that Africans exhibit a higher genetic propensity of hypertension (Pickering 2001).

Study context

Available evidence show that SSA is the last region to undergo the nutrition transition, even though individual countries and different locations within countries are in various stages (Delisle et al. 2013). According to a study conducted by Abrahams et al. (2011) in 40 SSA countries, approximately two-thirds of the countries are still in the receding famine stage, with poverty, child malnutrition, and high infant mortality rate being common in such countries. On the other hand, South Africa, Gabon, Cape Verde, Senegal, and Ghana are reported to be in more advanced stages of the transition, with high levels of energy-dense food consumption, high prevalence of overweight/obesity, and a higher mortality rate due to NCDs.

The trends are not surprising, considering current urbanization rates in SSA and the established connections between urbanization and nutrition transition associated with obesity (Agyei-Mensah and De-Graft Aikins 2010). Cities are recording exponential growths in populations, largely because of increased rural to urban migration and partly due to natural growth of urban population (Bosu 2015). It is estimated that 50% of the population in Africa will be urban dwellers by 2020 (Garrett and Ruel 2000). Exposure to urban lifestyle has rapidly westernized local populations, whereby dietary behaviors such as street food consumption, snacking between meals, and regular dining at fast-food restaurants have become popular (Dinsa et al. 2012; Delisle et al. 2013; Dake et al. 2016). Additionally, occupational changes, an increase in the participation of women in labour markets, and changes in family units have further encouraged eating away from home as a result of time constraints in preparing home meals (Popkin 2001). All this is happening in an environment characterised by ubiquitous mushrooming of supermarkets and fast-food restaurants, which have made western diets more accessible, replacing traditional food markets that have always provided the healthier alternatives (Delisle et al. 2013; Dake et al. 2016).

It is evident that the urban space plays a pivotal role in determining obesity and, by extension, nutrition-related NCDs in SSA (Ziraba et al. 2009). However, this complex relationship has received little attention, more so from a life-course perspective. Furthermore, it is also emerging that the urban lifestyle associated with western diets is no longer restricted within urban environments, as obesity prevalence continues to rise in rural areas of SSA (Madise and Letamo 2017). Ghana is among the countries in the sub-region experiencing rapid rural–urban transformations due to economic growth. The observed rural–urban transformations are associated with patterns of obesity prevalence where wide variations exist, with higher obesity prevalence recorded in urban locations (Biritwum et al. 2005; Agyemang et al. 2009). The observed obesity trends raise questions about how residential settings

may impact obesity prevalence in the country. We take on this challenge by examining the connection between childhood and adult residential settings and obesity incidence in Ghana.

Materials and methods

This study used data from the first wave of the World Health Organisation (WHO) Study on Global Ageing and Health (SAGE), from Ghana. SAGE was conducted in five countries; China, Ghana, India, Mexico, and the Russian Federation. In Ghana, data were collected from respondents between January 2007 and December 2008 via face-to-face interviews. The data are nationally representative, with an over-representation of persons 50 years and older due to the focus of SAGE. Nonetheless, SAGE includes a smaller sample of adults aged between 18 and 49 years for comparison purposes. A multi-stage design was used in recruiting participants for the study. In the first stage, the sample was stratified by all ten administrative regions and by rural/urban location. This was followed by the selection of 235 enumeration areas (EAs) as primary sampling units. In instances where EAs did not have residents who are 50 years or older, they were eliminated from the data collection. Within each eligible EA, about 20 households were further selected. Each of the selected households had at least one resident who was 50 years or older and four residents between the ages of 18 and 49. In total, 5573 individuals (men = 2799 and women = 2764) nested within 5269 households participated in the survey. The estimated response rate at the household level was 86 and 80% at the individual level (Biritwum et al. 2013). Missing cases were eliminated from the analysis leaving a final analytical sample of 4368.

Measures

Dependent variable Our dependent variable for this study was obtained from calculations of body mass index (BMI) using measurements of respondents' height and weight. BMI was obtained by dividing respondents' weight (in kilograms) by the square of their height (in meters). Using the WHO's recommended classification, we coded BMI as 1 = underweight < 18.50 kg/m^2, 2 = normal (18.50–24.99 kg/m^2), 3 = overweight (25–29.99 kg/m^2) and 4 = obese (≥ 30 kg/m^2). Finally, we recoded BMI into whether respondents were obese ('1') or not obese ('0').

Focal independent variable We obtained our focal independent variable for this study, residential histories, from two questions. The first elicited information on childhood residence: "where did you live most of your childhood (age 9 or younger)?". The second question elicited information on adult residence: "where did you live most of your adult life (18+ years)?". Both questions had the following possible responses: (i) in same community/locality/neighborhood, (ii) in another city in this region, (iii) in another rural area in this region, (iv) in another city outside this region but in the country, (v) in another rural area outside this region but in the country, and (vi) outside the country. We combined and re-categorized the responses to capture whether participants had urban or rural childhoods and whether they lived most of their adult life in urban or rural areas. In the case of respondents who indicated they always lived in the same location, we used information from respondents' current location to determine whether they live in rural or urban areas. By cross-classifying the two variables on childhood and adult residence we obtained a new variable (i.e., *residential history*). This new variable allows us to observe nuances of how residence at two stages of the life course jointly influence current obesity status. Residential history was coded as follows: childhood & adulthood in same rural area = 1, childhood & adulthood in different rural areas = 2, rural childhood–urban adulthood = 3, urban childhood–rural adulthood = 4, childhood & adulthood in different urban areas = 5, childhood & adulthood in same urban area = 6.

Other study variables To capture respondents' *childhood circumstances*, we included the following variables: mother's education, mother's employment, father's education, and father's employment. We included respondents' *demographic and socioeconomic factors* to examine their relationship with obesity. The following demographic and socioeconomic factors were included: age, gender, ethnicity, education, sector of current or sector of former occupation if currently retired, marital status, religion, and income quintile. Finally, we included certain behavioural and *lifestyle-related factors* which are associated in the literature with obesity, including current use of tobacco, alcohol use in the last month, fruit and vegetables consumption in a typical day, and physical activity.

Analytical strategy

Our dependent variable — obesity — was asymmetrically distributed between the dichotomous categories (not obese = 88%; obese = 12%). Thus, using the logit link function, which assumes a symmetrical distribution, may produce biased parameter estimates. Consequently, we used the negative log–log link function to adjust for the skewed distribution. We imposed respondents' ID numbers as a 'cluster' variable in our models to account for the hierarchical nature of the data. Standard regression models assume the independence of observations, unlike in SAGE data where respondents were nested with households. We employed descriptive statistics as well as bivariate and multivariate techniques to examine the relationship between residential histories and obesity. In model 1 of the multivariate analysis, we estimated the relationship between obesity and residential histories while accounting for selected control variables. Model 2 included

childhood parental factors in addition to model 1. In model 3, we adjust for respondents' socioeconomic and demographic factors in addition to the factors in model 2. Adjusted odd ratios (AOR) and robust standard error are reported. All analyses accounted for the weighting variable included in the data and were performed using STATA 14.

Results

Sample characteristics

We present the general distribution of the study variables in Table 1. Some 12% of the sample were found to be obese. Most of the study respondents had lived in the same rural (39%) or urban (30%) all their life. About 10% of respondents lived their childhood and adult life in two different rural areas, while some 7% spent their childhood and adulthood in two different urban areas. Only 5% of respondents indicated they lived their childhood in an urban area and their adulthood in a rural area. In contrast, almost 9% of respondents indicated they spent their childhood in a rural area and their adulthood in an urban area. A majority of respondents (~85%) indicated that their mothers had no formal education, while those whose mothers had primary and secondary education or higher constituted about 9% and 6% respectively. An overwhelming proportion of respondents indicated their mothers were self-employed (~87%), with less than 5% being unemployed. Most respondents (~69%) indicated their fathers had no formal education. Respondents whose fathers who had primary education and secondary education or higher constituted 11% and 20% respectively. Akans were the largest proportion of study participants (~55%) followed by respondents whose ethnicity were categorized as other (21%). The remaining proportion of respondents' ethnicities were Ga-Adangbes (~11%), Gruma (5%), Ewe (5%), and Mole–Dagbani (3%). Majority of respondents were self-employed (~80%), married (73%) and Christian (~76%).

Bivariate association between obesity and residential history

We found significant bivariate association between residential history and obesity (Table 1). About 44% of people who spent most of their childhood and adult life in the same urban area were obese, compared to 18% of those who spent most of their childhood and adulthood in the same rural area. Also, some 20% of respondents who had their childhood and adulthood in two different urban areas were obese, compared to 3% of people who spent their childhood and adulthood in two different rural areas. The findings from this analysis suggest that living in urban areas during childhood and adulthood may have a double impact on obesity. About 10% of people who had their childhood in rural areas and their adulthood in urban areas, compared to 5% of people who had their childhood in urban areas and their adulthood in rural areas, were obese. This also suggests that living in urban areas later in life (i.e., adulthood) is positively associated with obesity.

Multivariate negative log–log regressions predicting obesity

In model 1, we found a significant association between residential history and obesity (see Table 2). Respondents who lived in the same urban area during their childhood and adult life were 1.65 times more likely to be obese relative to those who lived their childhood and adult life in rural areas. The odds for obesity among respondents who lived in one urban area during childhood and lived in a different urban location for most of their adult life was 2.61 times higher relative to respondents who lived their childhood and adult life in rural areas. Respondents who had rural childhoods but lived in urban areas for most of their adult life were 1.41 times more likely to be obese, compared to those who lived both childhood and adulthood in the same rural area. Physical activity was significantly associated with being obese. Respondents who engaged in mild physical activity relative to those who were not physically active were 23% less likely to be obese. Engaging in extreme physical activity was associated with 0.72 lower odds of obesity compared to those not engaged in physical activity.

Model 2 examines the relationship between residential history and obesity, adjusting for childhood circumstances and lifestyle variables. Respondents who lived in the same urban area during both childhood and their adult life were 56% more likely to be obese compared to those who lived in the same rural area during their childhood and adulthood. Living in different urban locations during childhood and adulthood was associated with 2.45 higher odds of being obese compared to those who lived in the same rural location during their childhood and adulthood. The odds of those who lived in rural locations during their childhood and lived most of their adult life in urban locations being obese was 1.35 times higher than those who lived in the same rural location for their childhood and adulthood. Respondents whose mothers had secondary education or higher had lower odds of obesity compared to their counterparts whose mothers had no formal education. Respondents who engaged in mild or extreme physical activity were each less likely to be obese relative to those who did not engage in any physical activity.

The relationship between residential history and obesity remained robust after adjusting for socio-demographic factors and childhood parental circumstances in model 3. Those who

Table 1 Distribution of study variables by obesity ($n = 4368$)

	All (%)	Not obese (%)	Obese (%)	χ^2 value
Obesity				
Not obese	87.7			
Obese	12.3			
Residential history				230.71***
Same rural area	38.8	41.7	17.8	
Different rural areas	10	11	3.3	
Rural childhood–urban adulthood	8.5	8.3	9.8	
Urban childhood–rural adulthood	5	5.1	4.8	
Different urban areas	7.3	5.5	20.3	
Childhood & adulthood in same urban area	30.4	28.6	43.9	
Mother's education				19.57***
No formal education	84.9	85.2	82.6	
Primary	8.8	8.5	11.1	
Secondary+	6.3	6.3	6.2	
Mother's employment				12.35**
Unemployed	4.1	4.1	4.3	
Self-employed	86.6	86.4	88.1	
Public/private	2.9	2.6	4.9	
Informal sector	6.4	6.9	2.7	
Father's education				127.76***
No formal education	68.9	69.9	61.3	
Primary	11	11.2	9.4	
Secondary+	20.2	18.9	29.3	
Father's employment				71.15***
Unemployed	1.9	2.1	1.1	
Self-employed	75.3	76.8	64.2	
Public/private	17.6	15.8	31	
Informal sector	5.1	5.4	3.6	
Gender				75.26***
Male	53.7	53.8	32.2	
Female	46.3	46.2	67.8	
Ethnicity				67.01***
Akan	54.9	55.1	53.2	
Ewe	5.1	4.7	7.9	
Ga–Adangbe	10.9	10	17.6	
Gruma	5.3	4.9	7.7	
Mole–Dagbani	2.9	3.2	0.5	
Other	21	22.1	13.2	
Educational level				43.08***
No formal education	27.6	28.7	20	
Primary	33.2	33.1	33.7	
Secondary	34.8	33.8	42	
college/University	4.4	4.4	4.4	
Employment				2.65 ns
Self-employed	79.7	79.3	83.3	
Public	8	8.6	3.7	
Private	5.5	4.8	10.3	
Informal sector	6.7	7.3	2.7	
Marital status				14.53**

Table 1 (continued)

	All (%)	Not obese (%)	Obese (%)	χ^2 value
Married	73	73.8	67.1	
Separated/divorced	9.3	9	11.9	
Widowed	10.2	9.9	12	
Never married	7.5	7.3	9	
Religion				34.07***
Christian	76.4	75	86.5	
Muslim	14.1	14.7	9.2	
Traditional	5.6	6	3.2	
Other	0.9	1	0.1	
None	3	3.3	1	
Income quintile				178.67***
Poorest	14.4	15.3	8.2	
Poorer	17.7	19.3	5.7	
Middle	19.5	20.1	15.8	
Richer	22.7	21.8	29	
Richest	25.7	23.6	41.3	
Smoking tobacco				31.86***
Non-smoker	92	91.6	94.8	
Daily	5.5	5.9	2.4	
Not daily	2.6	2.5	2.9	
Alcohol use				19.82***
Non-drinker	42.8	42	48.1	
Last 30 days	30.9	31.7	24.9	
30+ days ago	26.4	26.3	27	
Fruit/vegetable consumption per day				11.99**
None	9.3	9.6	7.7	
1–3	72.9	72.9	73	
4+	17.7	17.5	19.3	
Vigorous activities				9.83*
None	49.9	48.9	56.6	
Mild	15.5	16.5	8.4	
Moderate	19.8	19.3	23.6	
Severe	9.4	9.5	8.6	
Extreme	5.4	5.8	2.7	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

lived in the same urban location during their childhood and most of their adult life were 1.44 times more likely to be obese compared to those who lived in the same rural location during their childhood and adulthood. Also, compared to respondents who lived both their childhood and adult life in the same rural location, those who lived in different urban locations during their childhood and most of their adult life were 2.37 times more likely to be obese. Respondents whose mothers had secondary education or higher were less likely to be obese compared to those whose mothers had no formal education. Respondents whose fathers had primary education were less likely to be obese compared to those whose fathers had no formal education. Respondents whose fathers worked in the informal sector had 80% likelihood of obesity compared to those whose fathers were unemployed. Female respondents were 1.46 times more likely to be obese compared to males. We found income quintile was a predictor of obesity among respondents. Compared to the poorest respondents, those who were *richer* or *richest* were 34 and 64% more likely to be obese, respectively. Two lifestyle factors were significantly associated with obesity in the final model. Respondents who indicated they consumed alcohol in the last 30 days or more were less likely to be obese relative to those who do not consume alcohol. Respondents who engaged in mild physical activity were less likely to be obese compared to those who did not participate in any physical activity.

Table 2 Negative log–log regression models of obesity among Ghanaians ($n = 4368$)

Variables	Model 1 AOR (robust std. err.)	Model 2 AOR (robust std. err.)	Model 3 AOR (robust std. err.)
Residential history (ref: childhood & adulthood in same rural area)			
Different rural areas	0.89(0.17)	0.864(0.149)	0.90(0.14)
Rural childhood–urban adulthood	1.41(0.25)*	1.358(0.242)*	1.30(0.24)
Urban childhood–rural adulthood	1.34(0.28)	1.296(0.268)	1.34(0.30)
Different urban areas	2.61(0.51)***	2.45(0.48)***	2.37(0.46)***
Childhood & adulthood in same urban area	1.65(0.18)***	1.56(0.17)***	1.44(0.17)***
Childhood parental circumstances			
Mother's educational level (ref: no formal education)			
Primary		0.964(0.166)	0.92(0.16)
Secondary/higher		0.64(0.126)**	0.58(0.11)***
Mother's occupation sector (ref: unemployed)			
Self-employed		1.218(0.271)	1.131(0.264)
Public/private sector		1.567(0.526)	1.70(0.58)
Informal sector		0.679(0.196)	0.69(0.20)
Father's educational level (ref: no formal education)			
Primary		0.820(0.110)	0.720(0.103)**
Secondary/higher		1.091(0.179)	0.94(0.14)
Father's occupation sector (ref: unemployed)			
Self-employed		0.965(0.194)	1.02(0.30)
Public/private sector		1.212(0.283)	1.20(0.37)
Informal sector		1.475(0.423)	1.80(0.64)*
Socioeconomic & demographic factors			
Age			1.00(0.00)
Gender (ref: male)			
Female			1.46(0.16)***
Ethnicity (ref: Akan)			
Ewe			1.44(0.27)*
Ga–Adangbe			1.50(0.23)***
Gruma			1.42(0.23)**
Mole–Dagbani			0.50(0.13)***
Other			0.95(0.13)
Educational level (ref: no formal education)			
Primary			1.13(0.15)
Secondary			1.175(0.167)
University+			1.01(0.23)
Occupation sector (ref: self-employed)			
Public			0.53(0.07)***
Private sector			1.21(0.25)
Informal Sector			0.84(0.12)
Marital status (ref: married)			
Separated/divorced			1.01(0.14)
Widowed			1.11(0.17)
Never married			0.96(0.18)
Religion (ref: Christian)			
Muslim			1.01(0.17)
Traditional			1.12(0.25)
Other			0.40(0.12)***
None			0.77(0.16)

Table 2 (continued)

Variables	Model 1 AOR (robust std. err.)	Model 2 AOR (robust std. err.)	Model 3 AOR (robust std. err.)
Income quintile (ref: poorest)			
Poorer			0.80(0.12)
Middle			1.13(0.18)
Richer			1.34(0.21)*
Richest			1.64(0.27)***
Lifestyle variables			
Smoking tobacco (ref: non-smoker)			
Daily	0.84(0.19)	0.80(0.17)	0.92(0.19)
Not daily	1.14(0.32)	1.094(0.28)	1.41(0.35)
Alcohol consumption (ref: non-drinker)			
Last 30 days	0.89(0.101)	0.864(0.0960)	0.87(0.10)
30+ days	0.90(0.10)	0.864(0.09)	0.77(0.087)**
Fruit and vegetable consumption (ref: none)			
1–3 servings	1.145(0.177)	1.172(0.181)	1.198(0.21)
4+ servings	1.06(0.19)	1.098(0.196)	1.17(0.23)
Physical activity (ref: none)			
Mild	0.77(0.10)**	0.753(0.101)**	0.75(0.10)**
Moderate	1.015(0.122)	0.995(0.120)	1.031(0.125)
Severe	0.93(0.11)	0.91(0.12)	0.880(0.125)
Extreme	0.72(0.08)***	0.73(0.08)***	0.818(0.106)

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Discussion

The main objective of this study was to explore whether obesity among adults is associated with residential histories, taking into account individual socio-demographic factors and childhood parental circumstances. While many studies have shown rural–urban difference in obesity prevalence, evidence of differences in cumulative exposure to rural or urban environments is still lacking in many LMICs. Residential histories provide a valuable avenue for understanding cumulative effects of place on obesity prevalence and risks, particularly for countries undergoing demographic and epidemiologic transitions.

The findings suggest exposure to the same urban environment during childhood and adulthood, and exposure to different urban environments during childhood and adulthood are both associated with higher odds of obesity. The findings are consistent with other empirical studies that found strong relationships between cumulative urban exposure and obesity in Africa and elsewhere (Jones 2015). For example, a study in Cameroon found significant association between current and lifetime exposure to urban environment and obesity (Sobngwi et al. 2004). Angkrrawaranon et al., (2015) also found a significant association between early life urban exposure and obesity in Thailand. Particularly, young adults who had early life experiences in urban environments had increased risk of obesity, compared to young adults who had early life exposure in rural areas. Similarly, a study in Peru found increased risk of obesity among urban individuals and rural-to-urban migrants compared to their rural counterparts (Carrillo-Larco et al. 2016).

There are several plausible reasons for the association between exposure to urban environments and obesity. Urbanization in many African countries is often associated with decrease in physical activity, changing dietary patterns, and increased intake of ultra-processed foods (Ziraba et al. 2009; Dake et al. 2016). Cumulative exposure to these conditions over the life-course could serve as putative risk factors for obesity for those in urban areas compared to people in rural areas. As demonstrated by previous studies, incidence of obesity are heightened in instances of low physical activity and residential mobility to urban areas (Jones 2015).

Studies have shown that population units in the same region or country might be at dissimilar stages of the transition (Abrahams et al. 2011). As such, within developing countries, while populations in rural areas may be characterised by receding famines and appropriate energy consumption–expenditure balance, their counterparts in urban areas may be associated with energy-dense diets and increasing sedentary lifestyles (Agyei-Mensah and De-Graft Aikins 2010). Due to these variations in the nutrition

transition across spatial contexts, related health outcomes including prevalence of NCDs and obesity are expected to differ between rural and urban areas within the same country.

Aside from early life exposure to urban environment, which is a key risk factor for obesity in adulthood, this study also found an association between education level of parents during childhood and obesity in adulthood. Particularly, education of the mother was found to be strongly associated with risk of obesity in later life. Children of mothers with primary education had lower risk of obesity compared to children of mothers with no formal education. Mothers' educational status could have a protective effect through better nutritional practices that could affect physical and emotional development. For example, better breastfeeding practices and control of fat intake among educated mothers could reduce risks of obesity in later years. Education among young women is also a major predictor of diet quality and dietary knowledge, which could be beneficial to their children (Ziraba et al. 2009; Bhurosy and Jeewon 2014).

Additionally, individuals in the richest income quintile and females were significantly more likely to be obese. A systematic review by Dinsa et al. (2012) found that risk of obesity in LMICs is higher among people with higher levels of income compared to those in the lower income category. Other studies have found a positive association between higher incomes and obesity in several countries (Abubakari et al. 2008; Ziraba et al. 2009). This pattern might be explained by changing dietary and lifestyles among the rich who might patronize more processed and high-energy foods as a symbol of wealth.

Limitations

There are some limitations to the study worth acknowledging. First, the residential mobility measure during childhood and adulthood employed in this study does not account for specific amount of time spent in various locations. It does not account for short-term movements between locations which tend to characterize real-life behaviours. Second, exposure to rural or urban environments between 9 and 18 years was not accounted for in the study. Because of this, temporal association between urban exposure and obesity after 18 years should be interpreted with caution. Third, socio-political and cultural context of urbanity vary extensively across the country. This limits contextual generalizability and comparisons across regions. Fourth, not all known predictors were included in the analysis because we relied on secondary data. Finally, responses may be affected by recall bias due to time lag, which could affect data quality.

Conclusion

Evidence from the Ghana SAGE data suggests that cumulative exposure to the same urban environment or different urban environments is associated with an increased risk obesity. Research has shown that several features of the urban social (e.g., social capital, social efficacy) and built (e.g., availability of parks, public transportation) environments serve as risk factors for obesity. To design locally appropriate public health interventions, further research is needed to understand contextually relevant features of the urban built and social environment that influence risk of obesity. Though the findings on lifestyle factors were inconclusive, and sometimes counterintuitive (particularly with respect to alcohol consumption), they offer important directions for future research and policy considerations. Future public health and epidemiological research should also refocus attention on understanding residential trajectories and early exposures to obesity risk factors to fully capture the pathways to obesity epidemic in the global south.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain information from studies on human participants or animals performed by any of the authors.

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