

## ORIGINAL RESEARCH

# Residing in economically distressed rural Appalachia is independently associated with excess body weight in college students

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## ABSTRACT

**Introduction:** The prevalence of obesity is greater among adults living in rural compared to urban areas of the USA. Greater obesity risk among rural adults persists after adjusting for obesity-related behaviors and sociodemographic factors. With the rural–urban obesity disparity greatest among younger adults, it is important to examine the complexity of factors that may increase the risk for excess body weight in this population so that effective preventive interventions can be implemented. College students residing in economically deprived rural areas such as rural Appalachia may be particularly at risk for excess body weight from exposure to both rural and college obesogenic environments. The purpose of this study was to determine if living in economically distressed rural Appalachia is independently associated with excess body weight among college students.

**Methods:** College students aged 18–25 years who were lifetime residents of either rural Eastern Appalachian Kentucky ( $n=55$ ) or urban Central Kentucky ( $n=54$ ) participated in this cross-sectional study. Students completed questionnaires on sociodemographics, depressive symptoms, and health behaviors including smoking, fruit and vegetable intake, and physical activity. Height and weight were obtained during a brief health examination to calculate body-mass index (BMI). Excess body weight was defined as being overweight or obese with a BMI of 25 kg/m<sup>2</sup> or greater. Binary logistic regression was used to determine if living in economically distressed rural Appalachia was independently associated with excess body weight.

**Results:** The prevalence of excess body weight was higher in the rural Appalachian group than the urban group (50% vs 24%,  $p<0.001$ ). Depressive symptom scores and smoking prevalence were also greater in the rural Appalachian group.



There were no differences in fruit and vegetable intake and vigorous physical activity between the groups. Residing in economically distressed rural Appalachia was associated with more than a six-fold increased risk of overweight or obesity, controlling for sociodemographics, depressive symptoms, and health behaviors (odds ratio=6.36, 95%CI=1.97–20.48,  $p=0.002$ ).

**Conclusions:** Living in economically distressed rural Appalachia was associated with excess body weight in college students independent of sociodemographic factors, depressive symptoms, and obesity-related behaviors. Further research is needed to determine other characteristics of this region that are associated with excess body weight so that effective programs to reduce obesity risk can be implemented.

**Key words:** Appalachia, college students, obesity, overweight, USA.

## Introduction

Excess body weight is a significant public health concern in the USA with approximately 70% of adults being overweight or obese<sup>1</sup>. Several investigative groups have documented a rural–urban obesity disparity with 36–40% of rural residents being obese compared to 30–33% of urban residents<sup>2,3</sup>. Excess body weight is associated with numerous chronic conditions including cardiovascular disease (CVD), cancer, diabetes, hypertension, arthritis, and asthma<sup>4–12</sup>, which may contribute to other rural health disparities such as reduced life expectancy and higher CVD mortality<sup>13–15</sup>.

Despite being socioeconomically disadvantaged and encountering numerous barriers to living healthy lives<sup>16–20</sup>, rural residents are more likely to be obese than urban residents, independent of diet, physical activity, and sociodemographic factors<sup>2,3,21,22</sup>. These studies support a growing body of research suggesting that broader neighborhood characteristics are associated with poor health outcomes independent of individual-level factors. Living in a disadvantaged neighborhood, for example, has been associated with a greater likelihood of developing coronary heart disease independent of personal socioeconomic status and risk factors<sup>23</sup>. Rural residents living in economically disadvantaged areas may therefore experience the greatest risk for excess body weight.

Appalachia is a 531 000 km<sup>2</sup> region in the USA encompassing 13 states following the Appalachian Mountains from northern Mississippi to southern New York<sup>24</sup>. Many counties within rural Appalachian Kentucky are economically among the worst 10% in the nation and are considered distressed by the Appalachian Regional Commission based on three indicators compared with national averages: 3-year average unemployment, per capita market income, and poverty<sup>25</sup>. Schoenberg and colleagues<sup>26</sup> recently reported that adults living in Appalachian Kentucky were more likely to be obese compared to those living in non-Appalachian Kentucky adjusting for sociodemographics, days of poor mental health, and smoking status. However, it's currently unknown whether living in distressed rural Appalachia is associated with excess body weight, adjusting for other weight-related behaviors. A greater understanding of independent community-level associations with excess body weight would be beneficial for policy makers and community leaders in considering comprehensive strategies to reduce weight-related chronic disease risk in this region.

With evidence that the rural–urban obesity disparity is greatest among younger adults<sup>2</sup>, the college years are an important time to examine the relationship between geographic residence and excess body weight. Many college students frequently consume fast food, do not consume the recommended amount of fruits and vegetables, and are physically inactive<sup>27–31</sup>, contributing to weight gain during the college years<sup>27,29,32,33</sup>. In addition to engaging in unhealthy behaviors, many college students also suffer from



psychological distress<sup>34,35</sup>, which is associated with weight gain in this population<sup>36</sup>. College students living in economically distressed rural Appalachia may be particularly at risk for excess body weight given broader neighborhood-level effects on health outcomes. Thus, the purpose of this study was to determine if living in economically distressed rural Appalachia is independently associated with excess body weight among college students.

## Methods

### *Design, setting, and sample*

Data from 54 students from urban Central Kentucky and 55 students from rural Eastern Appalachia Kentucky were included in this cross-sectional study. Students were recruited using purposive sampling from a community and a 4-year college in urban central Kentucky and a community college in rural Eastern Appalachian Kentucky. Students were eligible if they were 18–25 years of age, enrolled in college, and a lifetime resident of either rural Eastern Appalachian Kentucky or urban Fayette County, Kentucky. Lifetime residency of these counties was a criterion to minimize residential self-selection bias where people may choose their residence based upon environments that support their lifestyle preferences<sup>37–39</sup>. Students with a self-reported CVD diagnosis including hypertension, hyperlipidemia, and diabetes were excluded because they might be engaged in healthier lifestyle behaviors as part of their self-management. Pregnant students were excluded due to changes in body weight that occur during this period.

### *Measures*

**Rural Appalachian/urban non-Appalachian status:** Rural status was defined according to Rural–Urban Continuum Codes provided by the US Department of Agriculture<sup>40</sup>. Rural counties in this study had Rural–Urban Continuum Codes ranging from 7 to 9, indicating their status as non-metropolitan counties. These counties were defined as 'distressed' according to the Appalachian Regional

Commission, indicating they rank economically in the bottom 10% of all counties nationwide<sup>41</sup>. The eight rural Eastern Appalachian counties where data were collected have some of the highest rates of poverty and unemployment in Kentucky. Residents in these counties also have some of the worst overall health in the state<sup>42</sup>, with rates of heart disease mortality significantly higher than the national average<sup>43</sup>. In contrast, urban Fayette County in Central Kentucky, with a Rural–Urban Continuum Code of 2 (indicating metropolitan status) is a non-Appalachian county and has among the lowest rates of poverty and unemployment in the state. The Kentucky Institute of Medicine<sup>42</sup> ranked Fayette County as sixth best in the state for general health.

**Depressive symptoms:** Depressive symptoms were measured using the nine-item Patient Health Questionnaire (PHQ-9), which assessed the frequency of depressive symptoms over the previous 2 weeks and ranging from 0 (not at all) to 3 (nearly every day)<sup>44</sup>. Total score range was 0–27 with a score of 0–4 representing minimal symptoms, 5–9 mild symptoms, 10–14 moderate symptoms, 15–19 moderately severe symptoms and  $\geq 20$  severe symptoms. Cronbach's alpha range was 0.79–0.89 among individuals in primary care<sup>44,45</sup>.

**Fruit and vegetable consumption:** Fruit and vegetable consumption was measured using questions from the Behavioral Risk Factor Surveillance System<sup>46</sup> regarding the frequency of consuming 100% pure fruit juices, fruit, cooked or canned beans, dark green vegetables, orange-colored vegetables, and other vegetables. Participants could list the daily, weekly, or monthly frequency of consumption of each item during the past 30 days. Fruits and vegetables consumed daily were multiplied by 30 and those consumed weekly were multiplied by four to compute a monthly total. Daily fruit and vegetable intake was calculated by summing the monthly consumption of each item and dividing by 30 days.

**Smoking:** Smoking was self-reported from questions asking participants to indicate their smoking status, with options including 'currently smoking (smoking within 1 month of today)', 'recently smoked (stopped between 1 month and 1 year before



today)', 'formerly smoked (stopped more than 1 year ago)', and 'never smoked'. Smoking status was dichotomized into 'current or recently smoked' and 'formerly or never smoked'.

**Physical activity:** Vigorous physical activity was measured by the International Physical Activity Questionnaire short form (IPAQ-SF), which was designed to be used by adults aged 15–69 years<sup>47</sup>. The IPAQ-SF contains seven questions regarding the frequency and time spent in vigorous and moderate intensity activity, walking, and sitting. Vigorous physical activity was used in this analysis as it has the highest convergent validity with other measures of physical activity<sup>48</sup>. Weekly time spent in vigorous physical activity was calculated by multiplying the self-reported number of days engaged in vigorous physical activity by the self-reported time spent engaged in vigorous physical activity on one of those days.

**Excess body weight:** Participants were defined as underweight, normal weight, overweight, or obese class I–III according to standard BMI cut-points (<18.5, 18.5–24.9, 25–29.9, 30–34.9, 35–39.9, and  $\geq 40$  kg/m<sup>2</sup>, respectively)<sup>49</sup>. Body weight was measured using a portable, mechanical digital scale to the nearest 0.05 kg. Height was measured using a portable stadiometer to the nearest 0.1 cm with participants wearing no shoes and light clothing. Excess body weight was defined as a BMI  $\geq 25$  kg/m<sup>2</sup>.

**Other variables of interest:** A self-administered sociodemographic questionnaire was used to gather data on age, sex, race/ethnicity, household income, insurance status, having a primary care provider, and living arrangements.

## Procedure

Institutional Review Board approval was obtained prior to study initiation. Students were predominantly recruited on college campuses using recruitment tables staffed with study personnel. Flyers were emailed to students at each site and were posted at high traffic locations. The Center for Clinical and Translational Sciences at the 4-year college site provided recruitment assistance through a clinical research opportunities database.

Students who were interested and eligible scheduled a meeting with the principal investigator at a mutually agreed upon date and time to review the study, provide written informed consent, complete study questionnaires, and undergo a brief health examination where height and weight were measured.

## Data analysis

A small number of participants had missing or provided unusable data for some activity and dietary variables used in the analysis. In these cases, the means from each geographic area were used accordingly. Mean adjusted values for time spent in vigorous activity ( $n=2$ , urban;  $n=1$ , rural) were used because some participants provided unusable data on the IPAQ-SF by checking 'not sure/don't know.' Mean adjusted values for other vegetables ( $n=1$ , urban), daily fruit ( $n=1$ , rural), and total fruit and vegetables ( $n=1$ , rural) were also used for missing values.

Sociodemographics, depressive symptoms, health behaviors, and overweight or obesity were summarized using means with standard deviations, percentages, or medians with interquartile ranges as appropriate, and groups were compared using independent sample tests,  $\chi^2$ , or Mann–Whitney U-tests. Normality of the data were examined using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Depressive symptoms, fruit and vegetable intake, time spent in vigorous physical activity, and BMI were non-normally distributed. Binary logistic regression was used to determine whether living in rural Eastern Appalachian Kentucky was associated with excess body weight, controlling for sociodemographics, depressive symptoms, and health behaviors. The assumption of linearity between continuous variables and log of the outcome variable was tested by examining the interaction between each continuous variable and its log. There were no significant interactions, indicating that the assumption of linearity was met. The overall model  $\chi$  was used to assess the significance of the model, and the Hosmer–Lemeshow test was used to assess model fit. An alpha level of 0.05 was used to determine statistical significance for all analyses. All statistical analyses were performed using the Statistical Package for the Social Sciences v23 (IBM; <http://www-01.ibm.com/software/analytics/spss/>)



## *Ethics approval*

This study was approved by the University of Kentucky Institutional Review Board (12-0927).

## Results

### *Sociodemographic characteristics of participants*

Table 1 shows differences in sociodemographic characteristics between the groups. The mean age of the rural Eastern Appalachian Kentucky group was 1 year younger and that group completed approximately 1 less year of school than the urban Central Kentucky group. A greater percentage of the rural Eastern Appalachian Kentucky group was Caucasian/White, lived with family, reported lower household income, and fewer currently had insurance or a primary care provider.

### *Differences in depressive symptoms, health behaviors, and body weight*

Table 2 shows differences in depressive symptoms, health behaviors, and overweight and obesity between the groups. Approximately 60% of students in the rural Appalachian group had mild to moderate depressive symptoms compared to 26% in the urban Central Kentucky group. More than triple the number of students (42% vs 13%,  $p=0.001$ ) in the rural Appalachian group were current or recent smokers, and the median BMI (25.4 vs 23.2,  $p=0.037$ ) and proportion of students who were class II and class III obese (25% vs 0%,  $p<0.001$ ) were greater in this group. There were no differences in self-reported fruit and vegetable intake and vigorous physical activity between the groups.

### *Association between rural Appalachian/urban status and excess body weight*

Table 3 shows the binary logistic regression model (Cox and Snell  $R^2=0.214$ ; Nagelkerke  $R^2=0.291$ ; omnibus test of model  $\chi^2=26.231$ ,  $p=0.002$ ) of the association of rural

Appalachian/urban residency and excess body weight controlling for sociodemographics, depressive symptoms, and health behaviors. Living in rural Eastern Appalachian Kentucky was independently associated with more than a six-fold increase in odds of having excess body weight (OR=6.36, 95%CI=1.97–20.48,  $p=0.002$ ). Being male was also associated with higher odds of having excess body weight (OR=3.91, 95%CI=1.51–10.18,  $p=0.005$ ). Sociodemographic factors, depressive symptoms, and health behaviors were not associated with excess body weight.

## Discussion

College students who were lifelong residents of rural Appalachian Kentucky were at greater risk for having excess body weight than those living in urban, central Kentucky. Greater risk for excess body weight was independent of sociodemographic factors, depressive symptoms, and health behaviors. This is the first study to highlight the important impact that economically distressed rural environments have on the risk for excess body weight in college students who are already at high risk for weight gain.

This study adds to the growing body of knowledge regarding the influence of broader neighborhood and community-level factors on health outcomes and complements previous studies linking poor community-level socioeconomic conditions with unfavorable health outcomes. Neighborhood poverty has been associated with remaining obese during the transition from adolescence to young adulthood<sup>50</sup>, and living in a disadvantaged neighborhood has been associated with greater risk of coronary heart disease independent of individual socioeconomic status and cardiovascular risk factors<sup>23</sup>. Among children aged 10–17 years, 18% of state-level obesity prevalence has been attributed to area poverty after adjusting for individual socioeconomic and behavioral factors<sup>51</sup>. Policy-level strategies that improve economic conditions of deprived rural areas may be effective in improving health outcomes and reducing rural health disparities.



**Table 1: Sociodemographic characteristics of college students in rural Appalachian Kentucky and urban Central Kentucky**

Variable	Total sample (n=109) Mean ± SD or n(%)	Rural Appalachian Kentucky (n=55) Mean ± SD or n(%)	Urban Central Kentucky (n=54) Mean ± SD or n(%)	p-value*
Age	20.2 ± 1.8	19.7 ± 1.7	20.7 ± 1.7	0.003
Education (years)	14.1 ± 1.5	13.4 ± 1.1	14.7 ± 1.5	<0.001
Female	62 (57%)	28 (51%)	34 (63%)	0.204
Race/ethnicity				
Caucasian/White	93 (85%)	54 (98%)	39 (72%)	0.001
African American	11 (10%)	0 (0%)	11 (20%)	
Other	5 (5%)	1 (2%)	4 (8%)	
Living arrangement				
With family	60 (55%)	43 (78%)	17 (31%)	0.001
With spouse	11 (10%)	8 (15%)	3 (6%)	
With friends	21 (19%)	1 (2%)	20 (37%)	
In dormitory	8 (7%)	0 (0%)	8 (15%)	
Other	9 (9%)	3 (5%)	6 (11%)	
Insured growing up	102 (94%)	50 (91%)	52 (96%)	0.251
Currently insured	75 (69%)	27 (49%)	48 (89%)	0.001
Had primary care provider growing up	98 (90%)	49 (89%)	49 (91%)	0.775
Currently has primary care provider	73 (67%)	31 (56%)	42 (78%)	0.017
Household income growing up				
<\$30,000	38 (35%)	32 (58%)	6 (11%)	<0.001
\$30,000–60,000	26 (24%)	14 (26%)	12 (22%)	
>\$60,000	45 (41%)	9 (16%)	36 (67%)	
Current household income				
<\$30,000	60 (55%)	36 (65%)	24 (45%)	0.032
\$30,000–60,000	22 (20%)	11 (20%)	11 (20%)	
>\$60,000	27 (25%)	8 (15%)	19 (35%)	

\* p-values from independent samples *t*-tests for continuous variables and  $\chi^2$  tests of association for categorical variables. SD, standard deviation.

Similar to the current study, living in distressed Appalachian counties has been independently associated with a greater likelihood of developing diabetes<sup>52</sup>, and diabetes is diagnosed earlier among residents living in these areas<sup>53</sup>. Findings from this study also complement those of Schoenberg and colleagues<sup>26</sup> who reported that obesity risk is greater among those residing in Appalachian Kentucky, controlling for sociodemographics, days of poor mental health, and smoking. Although the specific mechanisms responsible for these associations have yet to be elucidated, these collective findings demonstrate the impact of poor community-level socioeconomic conditions and health outcomes independent of individual-level factors.

Rural–urban disparities in weight status of children and adolescents have been well documented, with findings indicating greater risk for overweight and obesity among those living in rural areas<sup>22,54–56</sup>. Data from a recent meta-analysis of five studies indicate that children and adolescents living in rural areas have 26% greater odds of obesity compared to those in urban areas<sup>57</sup>. Findings from the current study fill an important gap in the literature by providing additional evidence that rural residency is an independent risk factor for excess body weight among college students.



**Table 2: Differences in depressive symptoms, health behaviors, and body weight between college students in rural Appalachian Kentucky and urban Central Kentucky**

Variable	Total sample (n=109) Median (IQR) or n(%)	Rural Appalachian Kentucky (n=55) Median (IQR) or n(%)	Urban Central Kentucky (n=54) Median (IQR) or n(%)	p-value*
Depressive symptoms	4 (2–7.5)	6 (3–9)	3 (1.8–5)	<0.001
Depressive symptom category				
Minimal symptoms	57 (52%)	19 (35%)	38 (70%)	0.003
Mild symptoms	37 (34%)	24 (44%)	13 (24%)	
Moderate symptoms	9 (8%)	8 (14%)	1 (2%)	
Moderately severe symptoms	5 (5%)	3 (5%)	2 (4%)	
Severe symptoms	1 (1%)	1 (2%)	0 (0%)	
Health behavior				
Recent/current smoker	30 (28%)	23 (42%)	7 (13%)	0.001
Total fruits and vegetables	2.5 (1.5–4.4)	2.8 (1.1–5)	2.3 (1.6–3.9)	0.727
VPA week total (min)	120 (0–329.7)	52.1 (0–315)	180 (0–348.2)	0.069
Body-mass index (kg/m <sup>2</sup> )	24 (22–27.7)	25.4 (22–35.1)	23.2 (22–24.9)	0.037
Body-mass index category				
Underweight	3 (3%)	3 (6%)	0 (0%)	<0.001
Normal weight	65 (60%)	24 (44%)	41 (76%)	
Overweight	21 (19%)	11 (20%)	10 (18%)	
Class I obese	6 (5%)	3 (5%)	3 (6%)	
Class II obese	5 (5%)	5 (9%)	0 (0%)	
Class III obese	9 (8%)	9 (16%)	0 (0%)	

\* p-values from independent samples Mann–Whitney U-tests for continuous variables and  $\chi^2$  tests of association for categorical variables. IQR, interquartile range. VPA, vigorous physical activity.

**Table 3: Factors associated with excess body weight in college students in rural Appalachian Kentucky and urban Central Kentucky**

Variable	OR (95%CI)	p-value*
Sociodemographic		
Male	3.91 (1.51, 10.18)	0.005
Female	Reference	
Not insured	0.59 (0.19, 1.78)	0.345
Insured	Reference	
Household income		
<\$30,000	0.31 (0.09, 1.01)	0.052
\$30,000–60,000	0.34 (0.09, 1.38)	0.131
>\$60,000	Reference	
Psychological		
Depressive symptoms	1.05 (0.94, 1.17)	0.391
Health behavior		
Former/never smoked	2.47 (0.82, 7.48)	0.108
Current/recent smoker	Reference	
Daily fruit/vegetable intake	1.12 (0.91–1.37)	0.287
Vigorous physical activity	1.00 (1.00–1.00)	0.601
Rural/urban status		
Rural	6.36 (1.97, 20.48)	0.002
Urban	Reference	

CI, confidence interval. OR, odds ratio.

\* p-values for variables included in the logistic regression model. Overall model  $\chi^2=26.231$ ,  $p=0.002$ ; model  $R^2=0.214$  (Cox and Snell) 0.291 (Nagelkerke); Hosmer and Lemeshow test  $\chi^2=9.122$ ,  $p=0.332$ .



College students are commonly known for engaging in unhealthy weight-related behaviors such as low fruit and vegetable intake, frequent fast food consumption, and sedentary lifestyles<sup>27-29,31</sup>. Unhealthy behaviors often worsen as younger adults transition further into adulthood<sup>58,59</sup>, making this a key population to examine factors associated with excess body weight. Although health behaviors were not associated with excess body weight in the current study, other investigative groups using large, nationally representative surveys have noted an increased obesity risk with unhealthy behaviors<sup>2,3</sup>. Thus, the current study may have been underpowered to detect significant associations between excess body weight and health behaviors.

In addition to demonstrating that living in rural Eastern Appalachian Kentucky was independently associated with excess body weight, class III extreme obesity ( $BMI > 40 \text{ kg/m}^2$ ) was more prevalent in this group compared to those living in urban Central Kentucky. This finding is alarming and indicates greater risk for obesity-related comorbidities that may develop in this population. Given the widespread agreement among rural health stakeholders that heart disease, stroke, and diabetes are high priority considerations<sup>60</sup>, researchers should collaborate with community partners to design interventions to reduce excess body weight in younger adults as a strategy to reduce chronic disease risk in rural areas.

Given the importance of social determinants of cardiovascular health that have been recently highlighted by the American Heart Association<sup>61</sup> and that Appalachian adults are often socioeconomically disadvantaged<sup>62</sup>, college students were recruited to partially control for the impact of socioeconomic status on excess body weight. However, increasing education attainment is reported to be more strongly associated with declining obesity prevalence in urban compared to rural areas<sup>2,63</sup>. This may be due to challenges faced by rural residents to access affordable, high-quality healthy foods and opportunities for physical activity<sup>17,64-66</sup>. Higher education may therefore be overshadowed by financial constraints and

limited opportunities to engage in healthy behaviors among rural residents.

Although adults living in rural areas are less likely to consume five or more daily servings of fruits and vegetables compared to those in non-rural areas<sup>67</sup>, fruit and vegetable intake did not differ between rural and urban samples in the current study. This finding was somewhat surprising given the low household incomes reported by the rural Appalachian sample. Factors other than access to affordable healthy fruits and vegetables may therefore play a larger role in whether college students consume the recommended amounts of fruits and vegetables and subsequently reduce their risk for excess body weight. Boone-Heinonen and colleagues<sup>68</sup> reported that supermarket and grocery store availability were generally not associated with meeting fruit and vegetable recommendations among young adults participating in the Coronary Artery Risk Development In Young Adults (CARDIA) study.

Being male was associated with more than an approximately four-fold increased risk for having excess body weight. Although the magnitude of this association was somewhat surprising, this finding is consistent with existing research that has demonstrated greater weight gain and risk of weight gain in college males than females<sup>32,69,70</sup>. Males in college have described numerous barriers to engaging in healthy behaviors including a perceived abundance of unhealthy foods and ignoring long-term consequences of unhealthy behaviors<sup>71</sup>, fewer males than females considering the nutritional content of food<sup>31,72,73</sup>, and males being less worried about their weight<sup>32</sup>. Therefore, it is possible that differences in unmeasured dietary and activity habits contributed to the greater risk for excess body weight among men in the current study.

Given the relationship between living in a disadvantaged neighborhood and poor health outcomes, depressive symptoms were speculated to be a contributing factor to the rural-urban disparity in excess body weight. Although students in the rural Appalachian group experienced more depressive symptoms, this was not a predictor of excess body



weight. Additional research is needed to determine if other psychosocial determinants contribute to the increased risk of excess body weight and other health outcomes among those living in disadvantaged regions.

Several limitations to this study should be recognized. The fruit and vegetable questions used in this study measured the frequency of consumption rather than serving sizes and were comparable with large epidemiological studies focused on eating behaviors<sup>74,75</sup>. A more comprehensive dietary assessment is needed to provide a better understanding of how dietary practices contribute to body weight among college students living in rural versus urban areas. Inaccuracies in self-reported vigorous physical activity could have also influenced the current study's findings. However, this was deemed unlikely because the IPAQ's assessment of vigorous physical activity has the highest concurrent validity with other forms of activity assessment<sup>48</sup>. Using objective measures of physical activity would offer additional insight regarding how activity frequency, intensity, and duration influence rural–urban disparities in excess body weight. Although consistent with the demographics of rural Eastern Appalachian Kentucky, this study's predominantly Caucasian sample limits the ability to examine racial differences, which is an important factor in considering risk for obesity by rural–urban status<sup>76</sup>. Finally, results should be interpreted with caution given the sample size. However, assuming that the probability of excess body weight among younger adults in the general population is 0.6<sup>1</sup>, this study was powered at 86% (alpha=0.05) given the observed odds ratio of 6.36 (G\*Power 3.1.9.2)<sup>77</sup>. Additional research is needed to validate the extent to which college students living in economically distressed rural areas are at greater risk for excess body weight than their urban counterparts.

This study has several strengths. First, only college students who were lifelong residents of their respective rural or urban counties were recruited to minimize residential self-selection bias. Controlling for residential self-selection was important because people may choose to live in environments that support their lifestyle preferences, which could confound the relationship between geographic residence and body

weight. Second, recruiting students without diagnosed CVD risk factors reduced the possibility that students were purposely engaging in healthy behaviors to manage medical conditions that would affect body weight. Consequently, this study provides a greater understanding of the obesogenic nature of rural environments.

## Conclusions

Excess body weight is a significant public health concern in the USA that disproportionately affects rural residents. Findings from this study suggest that living in economically distressed rural Appalachian Kentucky is associated with excess body weight in college students independent of individual-level socioeconomic factors, depressive symptoms, and health behaviors. Determining other factors contributing to excess body weight among people living in rural areas is needed to better inform interventions that address the obesity epidemic.

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