Original Research

The association between nutrition, physical activity, and weight status among adults in Georgia

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ABSTRACT

Background: Obesity is classified as having a body mass index (BMI) greater than 30 and is associated with higher risks of type 2 diabetes, coronary heart diseases, hypertension, and other adverse health outcomes. In 2015, the prevalence of self-reported obesity among adults in Georgia was 30.7. The present study focused on how, in 2015, lifestyle factors, specifically nutrition and physical activity levels, related with weight status in Georgia.

Methods: The dataset used for this analysis was from the 2015 Behavioral Risk Factor Surveillance System. The association between weight status (as measured by BMI) and nutrition and physical activity levels was examined by use of linear regressions, controlling for socio-demographic variables.

Results: The sample consisted of 3,543 adult respondents in Georgia, of whom 2,285 (64.5%) were overweight or obese. Regarding the variables assessing nutrition, vegetable consumption had a significant association with weight status: one unit increase in consumption of vegetables decreased BMI by 0.009 (p=0.039).

Conclusions: Vegetable consumption was negatively associated with BMI. Future research should examine, with more robust measures, the relationship between physical activity levels and weight status and determine how other lifestyle factors relate to weight status. This will become increasingly relevant, as the rates for obesity in Georgia and the United States continue to trend upward.

Key words: obesity, lifestyle factors, nutrition, physical activity, weight status, BMI

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INTRODUCTION

Obesity, defined as an excess accumulation of body fat, is associated with an increased risk for adverse health outcomes, such as type 2 diabetes, coronary heart disease, hypertension, sleep apnea, various types of cancers, and overall morbidity. Overweight and obesity are most commonly measured through body mass index (BMI); an individual with a BMI of 25-29.9 is considered overweight, and an individual with a BMI of 30 or over is considered obese (U.S. Department of Health and Human Services [HHS], 2013). About one third of adults in the United States are obese. In Georgia, the prevalence of self-reported obesity among adults was 31.4% in 2016. The adult obesity rate in Georgia has been increasing, and, across all states, Georgia ranks 20th in obesity (CDC BRFSS, 2016).

With some exceptions, obesity can be attributed to a positive energy balance (Hill et al., 2012), which refers to the situation in which energy consumed is greater than energy expended, leading to weight gain. Weight loss and maintenance, on the other hand, are associated with negative and neutral energy balance, respectively (Hill et al., 2012). There is an association between nutrition and weight status (Deshmukh-Taskar et al., 2010; Ledikwe et al., 2006; Malik et al., 2008; Utter et al., 2016). However, the reported studies are not specific to the state of Georgia. Since the incidence of chronic diseases and associated costs for health care are increasing, it is necessary to understand the relationship between nutrition, physical activity, and obesity in Georgia. Findings on the effects of fruit consumption, vegetable consumption, and physical activity can inform the design of interventions to address the issue of obesity at the policy level.

In view of the high prevalence and negative health outcomes of being overweight and obese, there is a need for research that examines how lifestyle factors, including food behavior and physical activity, influence the weight status of individuals. The present study utilized publicly available data from the 2015 Behavioral Risk Factor Surveillance System (BRFSS) survey, collected by the Centers for Disease Control and Prevention (CDC), which asks questions pertaining to the consumption of fruits and vegetables and levels of physical activity. The present effort focused on fruit and vegetable consumption, physical activity levels, and weight status.

METHODS

Data

This quantitative study utilized cross-sectional data from the 2015 BRFSS, a publicly available dataset on health-related risk factors, including data on intake of fruits and vegetables and physical activity. The BRFSS is a state-based telephone survey conducted by the CDC. The dataset is publicly available on their website at www.cdc.gov. The BRFSS includes data on a variety of health-related risk factors such as weight status, healthcare access, nutrition, physical activity level, and personal demographics among a representative sample of U.S. residents. The dataset also contains state identifiers, allowing this study to be conducted for the state of Georgia. Further, it allows adjustments for confounding demographic variables that could affect the association between nutrition, physical activity, and weight status. The BRFSS, a reliable source for data (Li et al., 2012; Nelson et al., 2001; Nelson et al., 2003; Pierannunzi et al., 2013), is one of the largest telephone surveys, with more than 400,000 people completing the survey in 2013 (Pierannunzi et al., 2013).

Nutrition was assessed in terms of frequency of fruit and vegetable consumption. Specifically, the survey captured the consumption frequency by fruits and vegetables categories. The categories were: 100% fruit juice, fruit, dark green vegetables, orange-colored vegetables, and "other" vegetables. For each of these categories, respondents were asked: "During the past month, how many times per day, week or month did you eat/drink [fruits and vegetables] category?" The responses on consumption frequency were by the day, by the week, or by the month. For the analysis, the by-the-day and by-the-week consumption frequencies were recoded to be expressed on a per-month basis. The per-day observation was transformed into per-month consumption frequency by multiplying the per-day observation by 30 (number of days in a month). The per-week observation was transformed into per-month consumption frequency by multiplying the per-week observation by 4 (number of weeks in a month). Further, the five fruits and vegetables categories were consolidated into two measures: fruit consumption per month and vegetable consumption per month.

On behavior related to physical activity, the present study focused on whether the respondent had engaged in physical activity or not in the past month, and the duration of time that the respondent participated in this activity. Physical activity levels were captured with a question that asked respondents to identify whether they had engaged in physical activity in the past month ("During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?"). Weight status was based on self-reported height and weight data used to compute BMI, a measure of weight status. BMI is a person's weight in kilograms divided by the square of height in meters. This study followed the BMI categories in the BRFSS dataset defined by the Centers for Disease Control and Prevention (www.cdc.gov). These are a BMI > 30 for obese, a BMI 25 - <30 for overweight, a BMI 18.5 - <25 for normal weight, and a BMI of < 18.5 for underweight. These categories were used for tables, but, for the regression analyses, a continuous BMI measure was used.

Several demographic variables were selected as potential confounding variables. Table 1 contains the variables included in the analyses.

Table 1: Demographic variables from the 2015 BRFSS survey used for this study

Data	BRFSS Response Options
Weight status (BMI)	Continuous variable
State	13 – Georgia
Demographics	
Sex	Male; Female
Race	White only, non-Hispanic; Black only, non-Hispanic; American Indian or Alaskan Native only, non-Hispanic; Asian only, non-Hispanic; Native Hawaiian or Pacific Islander only, non-Hispanic; Other race only, non-Hispanic; Multiracial, non-Hispanic; Hispanic
Age	18-24; 25-34; 35-44; 45-54; 55-64; 65 or older
Marital Status	Married; Divorced; Widowed; Separated; Never married; A member of an unmarried couple; Refused
Education	Did not graduate high school; Graduated high school; Attended college or technical school; Graduated from college or technical school; Don't know/Not sure/Missing
Employment	Employed for wages; Self-employed; Out of work for 1 year or more; Out of work for less than 1 year; A homemaker; A student; Retired; Unable to work; Refused
Income	Less than $15,000; $15,000 to less than $25,000; $25,000 to less than $35,000; $35,000 to less than $50,000; $50,000 or more; Don't know/Not sure/Missing
Children	No children in household; One child in household; Two children in household; Three children in household; Four children in household; Five or more children in household; Don't know/Not sure/Missing

Data analysis

A multiple linear regression analysis was conducted to determine the effect of fruit and vegetable consumption and physical activity on the weight status of Georgia respondents. Consumption of fruits and vegetables was measured separately as consumption frequency per month.

As such, fruit consumption, vegetable consumption, and physical activity measures were regressed on BMI. BMI was measured as a continuous variable as calculated and reported by the BRFSS. The variables of interest were physical activity measure, fruit consumption, and vegetable consumption. In the model, confounding from demographic variables (sex, age, race, marital status, education, employment, income, and number of children) was controlled for. Stata 13.0 was used for the analysis.

RESULTS

Table 2 shows the demographic breakdown of respondents by BMI category. There were more overweight and obese individuals than individuals who were normal or underweight. Of the respondents, the predominant race was White - non-Hispanic, and most were older adults (45 and older). In accordance with this age composition, the most commonly reported marital status was “married.” Most respondents had at least a high school education and were either employed or retired. The most reported income bracket was over $50,000 per year, and most respondents had no children in the household.

Table 2: Demographics of respondents (%) by BMI categories in Georgia (3,543)

	BMI categories			
Demographic variables	<18.5	18.5 - <25	25 - <30	>30
	n=53	n=1,030	n=1,186	n=1,099
Gender				
Male	15.1	33.2	51.2	40.1
Female	84.9	66.8	48.8	59.9
Age				
18-24	5.7	7.6	3.1	1.7
25-34	9.4	11.6	8.2	9.5
35-44	3.8	13.4	12.1	11.7
45-54	13.2	16.9	17.0	19.3
55-64	20.8	18.2	24.3	26.9
65 and older	47.2	32.5	35.2	30.8
Race				
White only	73.6	73.1	67.1	62.6
Black only	13.2	19.4	25.0	32.0
American Indian or Alaskan Native only	1.9	0.8	1.1	1.0
Asian only	5.7	2.7	1.2	0.3
Native Hawaiian or Pacific Islander	-	0.1	0.1	0.2
Other race	-	0.2	0.2	0.4
Multiracial	1.9	1.2	1.4	0.7
Hispanic	3.8	2.5	4.0	2.8
Marital Status				
Married	37.7	49.1	55.3	53.2
Divorced	26.4	15.4	14.2	16.8
Widowed	18.9	13.6	13.1	11.5
Separated	-	2.4	2.7	3.1
Never married	17.0	16.6	12.8	13.6
A member of an unmarried couple	-	2.8	1.9	1.8
Education				
Did not graduate high school	15.1	7.7	9.6	11.2
Graduated high school	18.9	23.9	24.2	29.3
Attended college or technical school	32.1	24.2	24.9	29.4
Graduated from college or technical school	34.0	44.3	41.3	30.1
Employment				
Employed for wages	20.8	41.7	42.6	39.0
Self-employed	5.7	8.3	7.2	6.5
Out of work for 1 year or more	3.8	2.6	2.7	3.0
Out of work for less than 1 year	1.9	1.6	1.5	1.7
A homemaker	7.5	6.7	5.3	5.2
A student	1.9	4.6	1.8	1.4
Retired	43.4	27.8	31.7	27.6

	BMI categories			
Unable to work	15.1	6.9	7.3	15.7
Income				
Less than $15,000	17.0	10.1	9.9	15.1
$15,000 to less than $25,000	17.0	18.2	16.9	22.5
$25,000 to less than $35,000	15.1	10.8	11.1	11.2
$35,000 to less than $50,000	15.1	13.0	14.0	13.6
$50,000 or more	35.8	48.3	48.1	37.8
Children				
No children in household	81.1	16.8	75.9	73.3
One child in household	11.3	10.3	9.7	11.0
Two children in household	7.5	10.0	10.0	8.1
Three children in household	-	3.8	3.1	5.0
Four children in household	-	1.3	0.9	1.3
Five or more children in household	-	0.6	0.3	1.3

The frequency of respondents reporting engaging in physical activity, as opposed to no physical activity, was higher in all four BMI categories (Table 3).

Table 3: Respondents' physical activity (%) by BMI categories in Georgia (3,543)

BMI categories				
Physical Activity	<18.5	18.5 - <25	25 - <30	>30
	n=53	n=1,030	n=1,186	n=1,099
Engaged in physical activity in the past month	83.0	92.6	94.8	93.7
Not engaged in physical activity in the past month	17.0	7.4	5.2	6.3

Table 4 presents the results from multiple linear regression analyses. Vegetable consumption was significantly associated with weight status. For each unit increase in consumption frequency of vegetables in the past month, the BMI was lower by 0.009 (p=0.039, CI -0.017, 0.000). Fruit consumption in the past month was negatively associated with weight status, and physical activity was positively associated with weight status. In both cases, however the coefficients were not significant.

Various demographic variables showed significant associations with weight status. Females had a lower BMI than males by 0.505 (p=0.036). Compared to Whites, Blacks had higher BMIs by 1.409, and Asians had lower BMIs by 2.264 (p=0.000 and 0.023, respectively). All the age categories were significantly and positively associated with weight status as compared to the 18-24 age group; through the 45-54 age group, BMI increased with age. In terms of marital status, divorced and widowed individuals had lower BMIs than married individuals by -0.670 (p=0.043) and 1.319 (p=0.001), respectively.

There was no significant difference in weight status among the various educational levels, but individuals who are unable to work had higher BMIs than those employed for wages by 1.938 (p=0.000). Individuals with an income of $35,000-$50,000 had lower BMIs than those with an income of less than $15,000 by 1.238 (p=0.012); this difference was 2.047 lower for those making an income of more than $50,000. Compared to those with no children, individuals with one child had higher BMIs by 1.061 (p=0.007). Those with five children had higher BMIs than those with no children by 4.279 (p=0.001).

Table 4: Effect of fruit and vegetable consumption and physical activity on weight status for adults >18 years old in the state of Georgia

	Effect	p-value	95% CI
Dependent variable			
BMI			
Independent variables			
Gender			
Male	control		
Female	-0.505	0.036	-0.976, -0.034
Age			
18-24	control		
25-34	2.970	0.000	1.502, 4.438
35-44	3.464	0.000	1.961, 4.968
45-54	4.297	0.000	2.827, 5.768

	Effect	p-value	95% CI
55-64	4.196	0.000	2.698, 5.694
65 and older	3.522	0.000	195.45, 5.089
Race			
White only, non-Hispanic	control		
Black only, non-Hispanic	1.409	0.000	0.874, 1.944
American Indian or Alaskan Native only, non-Hispanic	0.861	0.435	-1.299, 3.021
Asian only, non-Hispanic	-2.264	0.023	-4.221, -0.308
Native Hawaiian or Pacific Islander only, non-Hispanic	2.393	0.445	-3.747, 8.534
Other race only, non-Hispanic	2.403	0.310	-2.236, 7.043
Multiracial, non-Hispanic	-0.836	0.454	-3.023, 1.351
Hispanic	0.017	0.981	-132.20, 135.51
Marital Status			
Married	control		
Divorced	-0.670	0.043	-1.376, -0.023
Widowed	-1.319	0.001	-2.104, -0.535
Separated	-0.726	0.316	-2.146, 0.694
Never married	-0.217	0.595	-1.016, 0.583
A member of an unmarried couple	-0.474	0.556	-2.055, 1.107
Education			
Did not graduate high school	control		
Graduated high school	0.299	0.496	-0.561, 1.158
Attended college or technical school	0.744	0.099	-0.139, 1.627
Graduated from college or technical school	-0.249	0.590	-1.154, 0.657
Employment			
Employed for wages	control		
Self-employed	-0.809	0.079	-1.711, 0.093
Out of work for 1 year or more	-0.590	0.401	-1.967, 0.786
Out of work for less than 1 year	-0.470	0.599	-2.223, 1.282
A homemaker	-0.434	0.415	-1.477, 0.609
A student	-0.940	0.259	-2.572, 0.691
Retired	-0.106	0.776	-0.833, 0.622
Unable to work	1.938	0.000	1.045, 2.831
Income			
Less than $15,000	control		
$15,000 to less than $25,000	-0.713	0.097	-1.554, 0.129
$25,000 to less than $35,000	-0.965	0.054	-1.946, 0.016
$35,000 to less than $50,000	-1.238	0.012	-2.206, -0.271
$50,000 or more	-2.047	0.000	-2.960, -1.134
Children			
No children in household	control		
One child in household	1.061	0.007	0.286, 1.836
Two children in household	-0.069	0.877	-0.949, 0.810
Three children in household	1.071	0.085	-0.150, 2.291
Four children in household	1.909	0.075	-0.192, 4.010
Five or more children in household	4.279	0.001	1.672, 6.887
Physical Activity			
No physical activity	control		
Physical activity	0.456	0.335	-0.471, 1.382
Nutrition			
Fruit consumption	-0.005	0.168	-0.013, 0.002
Vegetable consumption	-0.009	0.039	-0.017, 0.000

DISCUSSION

On average, the diet quality in the United States is far from ideal (Wang et al., 2014), with Americans often consuming nutrient-dense foods, such as fruits and vegetables, in quantities lower than those recommended by the U.S. Department of Agriculture (USDA) in their Dietary Guidelines for Americans. Instead, the average individual tends to over-consume energy-dense foods, often heavily processed and high in added fats and sugars (Troesch et al., 2015). Further, prevalence of obesity and associated chronic disease conditions are causing a public health crisis. Thus, it is necessary to understand factors associated with obesity, not only at the national level but also at the state level. The present study evaluated the effects of fruit consumption, vegetable consumption, and physical activity on weight status. The results showed that vegetable consumption was associated with weight status (BMI). Specifically, each unit increase in vegetable consumption – encompassing the consumption of dark green vegetables, orange vegetables, and “other” vegetables – was associated with a 0.009 decrease in BMI.

A previous study conducted with NHANES 2003-2010 data found that, for children, consumption of apples was associated with reduced risk of obesity (O’Neil et al., 2015). However, Bayer et al. (2014) found no significant association between fruit and vegetable consumption and BMI change in school-aged children. A study in Australia found that “total discretionary food/beverage consumption, defined as foods and drinks that are not necessary for a healthy diet, as well as discretionary foods and discretionary beverages independently were associated with BMI in Australian adults” (Sui et al., 2017). Thus, existing research on the association between fruits and vegetables consumption and weight status contains conflicting results. The studies also have limitations: they tended to examine data from the United States, which contains a diverse population, or that from countries with different norms and cultures, as opposed to a state such as Georgia, and most study populations consisted of children and adolescents.

A review of epidemiological studies on the relationship between fruit and vegetable consumption and body weight found inconsistent results in studies that did not adjust for confounders, but discovered two studies that identified a significant effect of vegetable consumption on BMI (Tohill et al., 2004). One of these found that obese men, after controlling for age, sex, and race/ethnicity, consumed significantly fewer servings of vegetables, excluding white potatoes, than non-obese men (Lin & Morrison, 2002). The second study found an inverse association between vegetable consumption and a change in BMI and waist circumference over a 10-year time span (Kahn et al., 1997).

The current study, which also revealed an inverse relationship between vegetable consumption and BMI, supports those findings. First, the analysis utilized the most recent data. In addition, many of the previous studies adjusted only for one or two demographic variables, such as sex and age. The present study utilized more rigorous data that allowed control of confounding demographic variables, such as sex, age, race, education, employment, income, marital status, and number of children in the household. Adjusting for these demographic variables lend confidence to the conclusion that vegetable consumption has a negative effect on BMI.

Although physical activity was not found to be significantly associated with weight status, this could have been because this variable was measured on a simple yes/no scale over the previous month. Further, this variable was evaluated only by asking if an individual had engaged in any type of physical activity in the past month. A more accurate relationship might have been apparent with a measure of frequency and duration of physical activity. Follow-up studies could examine the relationship between vegetable consumption and weight status, for example, by breaking down levels of consumption into low, medium, and high. In addition, limited evidence was available on the association between fruit and vegetable consumption and weight status.

The relationship between physical activity and weight status has been a topic of interest for researchers. One systematic review on physical activity and weight gain found that, when physical activity was measured during collection of follow-up data, it was inversely related to long-term weight gain (Fogelholm and Kukkonen-Harjula, 2000). This association was inconsistent with studies that collected a baseline level of physical activity and then randomized weight-reduction interventions among participants. Although the findings of this systematic review generally support the conclusion that physical activity is associated with weight status, the studies included in this review were restricted to those containing Caucasian (white) males (Fogelholm and Kukkonen-Harjula, 2000). Although additional reviews found support for the inverse relationship between physical activity and weight status with a broader study population than Caucasian males, these results have been disputed (Chung et al., 2012; Must and Tybor, 2005). For instance, a separate meta-analysis on school-based physical activity interventions found no significant improvement in BMI as a result of these interventions (Harris et al., 2009).

Limitations of the present study relate to the composition of the data. First, the nutrition data was self-reported: respondents were asked to report their frequency of consumption either per day, per week, or per month. As these are not mutually exclusive categories, there could have been confusion on how to report fruit and vegetable consumption accurately. Also, people may not correctly remember their food consumption and/or may feel pressured to report higher consumption frequencies for the survey. More generally, nutrition may not be adequately captured by information limited to the consumption of fruits and vegetables.

CONCLUSIONS

This study examined the relationship between lifestyle factors, specifically physical activity and nutrition, and weight status for adults in the state of Georgia. The most up-to-date data from the 2015 CDC BRFSS survey confirm that higher vegetable consumption predicts a lower BMI. Although, in future studies, measures for vegetable intake need to be improved, and higher vegetable consumption may be a proxy for an overall healthier diet (Verger, et al., 2017; Donini, 2016), this finding calls for efforts that continue to monitor diet change and weight status among Georgians. With the upwards trend in obesity rates in Georgia and the United States (Flegal, 2016), it will be appropriate to target dietary behaviors for prevention of obesity.

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