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Abstract

This observational study examined the association between food security and healthy weight in children ages 6 to 12, using the 2013-2014 NHANES cross-sectional survey. The relationship between children's food security and their weight was tested using logistic regression, while controlling for race, gender, physical activity, and poverty level. A significant association was found; children in households with low or very low food security were about 2.4 times more likely to be overweight than those with full or marginally secure food. Hispanic and multi-racial children were more than twice as likely to be overweight than white children. Children from low-income families, yet ineligible for food subsidies, were 62.4% more likely to be overweight or obese than those in higher income brackets. The significant relationship between food security and children's weight suggests that the current eligibility criteria for federal Supplemental Nutrition Assistance Program benefits, and the types of approved subsidized foods, should be revised so that low-income children have better access to higher-quality food. Gaps in access to nutritious food are indicative of larger social, political, and economic problems adversely impacting the health of children in economically disadvantaged groups.

Keywords: food security; childhood obesity; health disparities; food assistance.

Introduction

In recent years, there have been growing concerns that food insecurity and obesity may be related (Schafft, Jensen & Hinrichs, 2009; Jilcott et al., 2011; Kaur, Lamb & Ogden, 2015; Ogden et al., 2015; Kral, Chittams & Moore, 2017). In 2015, childhood obesity and food insecurity were at record highs in the United States; 17% of the children between ages 2 and 19 years were obese (Ogden et al., 2015; Kral, Chittams & Moore, 2017) and recent data showed that an estimated 14% of all households experienced food insecurity (USDA, 2018). Obesity disproportionately affects low-income populations in the United States, particularly African-Americans and Hispanics (CDC, 2018; McCurdy, Gorman & Metallinos-Katsaras, 2010; Jilcott et al., 2011; Long et al., 2012; Ogden et al., 2015), as do food insecurity and malnutrition (McCurdy, Gorman & Metallinos-Katsaras, 2010; Iriart et al., 2013; Elmes, 2016). Research supporting the relationship between food insecurity and high bodyweight in children (Schafft, Jensen & Hinrichs, 2009; Kral, Chittams & Moore, 2017) showed that children living in food insecure households were more likely to be obese than children living in food secure households (Larson, Story & Nelson, 2009; Kaur, Lamb & Ogden, 2015), and communities located in food-desert areas had higher rates of overweight children (Schafft, Jensen & Hinrichs, 2009) than those with better access to quality foods. It has been shown that nutritious foods are pricey (Kern et al., 2017), and that even "small increases in the price of healthy foods may increase food insecurity among those already at risk" (Morrissey, Jacknowitz & Vinopal, 2014).

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Both parents' knowledge on nutrition and access to quality foods appear to significantly influence child eating behaviors (Kral, Chittams & Moore, 2017) suggesting that childhood weight and eating behaviors should be analyzed within the framework of parent and familial involvement. Food insecure mothers can show a greater concern regarding their child's weight status and tend to intervene more frequently with restricting eating behaviors in their children when compared to food-secure mothers (Jilcott et al., 2011; Kral, Chittams & Moore, 2017). Nevertheless, maternal intervention appears to be associated with children consuming more snacks per day, eating past satiation more frequently, and to lead to odds of being obese about five times higher than the food secure children (Kral, Chittams & Moore, 2017). These findings are consistent with the Family Stress Model, which asserts that maternal behaviors are affected by socioeconomic barriers and can disrupt and adversely impact healthy parenting, leading to unhealthy outcomes, such as obesity, amongst food insecure children (McCurdy, Gorman & Metallinos-Katsaras, 2010).

Child obesity studies found an association between food insecurity and high body weight in kindergarten-age boys (Jyoti, Frongillo & Jones, 2005) or in girls (Burke et al., 2016), while others found no significant relationship between food security and weight in preschool aged children (Speirs & Fiese, 2016). In youth, it has been shown that those who experience food insecurity are more likely to experience nutritional and exercise barriers (Baer et al., 2018). The inverse relationship found between food security and children's weight suggests that children in low-income families are more likely to be overweight (Nguyen et al., 2017). Low-income families are unable to purchase nutritious foods and they may also lack adequate nutrition education that could improve personal purchasing habits and/or encourage the use of food assistance programs (McCurdy, Gorman & Metallinos-Katsaras, 2010; Elmes, 2016; Nguyen et al., 2017).

Inconsistencies in the results of studies on food security and its relation to child weight suggest that more research is needed. This study used a nationally representative dataset, the 2013-2014 National Health and Nutrition Examination Survey (NHANES), to investigate the association between food security and a child's healthy weight while controlling for children's age, race, gender, physical activity, and the ratio of family income to poverty. Further research aimed at exploring whether food assistance programs improve health outcomes should be conducted to reevaluate eligibility criteria and program value to the public, especially in view of tenuous political and fiscal support for nutrition assistance (Elmes, 2016).

Data and methods

The U.S. National Center for Health Statistics conducts the cross-sectional National Health and Nutrition Examination Survey (NHANES) with a national representative sample of the noninstitutionalized civilian U.S. population living in the 50 states and the District of Columbia. NHANES relies on a four-stage multistate probabilistic sample to assess and monitor the health and nutritional status of the US population (Johnson et al., 2014). The survey was administered in the home of selected participants. The household interview included two questionnaires: the first was a sample participant questionnaire – adults served as proxy for anyone under the age of 16 – to collect health and nutritional information of each individual, along with personal income and food availability within the household; and, the second questionnaire was answered by the head adult family member on behalf of every member in the household. NHANES also includes a standardized health examination at a mobile examination center specifically serving the sample's participants (Johnson et al., 2014).

The target population are the children ages 6 to 12 years old. The 2013-2014 data files were downloaded and merged using the Statistical Analysis System (SAS), then transferred to SPSS IBM SPSS® 25 (Statistical Package for the Social Sciences) for data analyses; the NHANES data was weighted for these analyses.

There were **two binary dependent variables** measuring the weight of children, where "1" indicated whether the child was overweight or obese. For the first ***dependent variable***, we used the body mass index (BMI) of children, a score computed based on the child's weight and height, which is available in the NHANES as a categorical variable coded as follows: (1) underweight

(BMI < 5th percentile), (2) normal weight (BMI 5th to < 85th percentiles), (3) overweight (BMI 85th to < 95th percentiles), and (4) obese (BMI ≥ 95th percentile). The cutoff criteria for the BMI categories were developed by the Centers for Disease Control and Prevention using United States' sex-specific 2000 BMI-for-age growth charts. For the purpose of the logistic regression, which requires a binary (1, 0) dependent variable, we recoded the variable with four categories described above into a variable with two categories, where the first two categories of this variable were recoded into category 0= normal/underweight and the last two categories were recoded into category 1=overweight or obese. Moreover, the overweight and obese categories were collapsed into a single category in order to achieve comparison with the second dependent variable where there was no differentiation made between being overweight and being obese.

The ***second dependent binary*** variable used in this study was developed based on two variables: one was about parents' perception that the child was overweight and the other asked the parents whether they were told by a doctor or a health professional that their child was overweight (coded 1) The Early Childhood portion of the NHANES survey allows the proxy to determine the evaluation of a participating child's current weight. The target population for these variables were females and males 2-15 years in age. The question asked was "How do you consider [your child] weight?" and the answer choices were (1) overweight, (2) underweight, (3) about the right weight. Further, there was a yes/no question: "Has a doctor or health professional ever told you that [the child] was overweight?". The NHANES variables, WHQ030E (How do you consider your child's weight?) and MCQ080E (Has a doctor or health professional ever told you that [your child] was overweight?), were combined and recoded into a new binary variable where 0 indicated "not overweight" and 1 indicated "overweight" in children.

The independent variables included the child's race, gender, and age group, his/her level of physical activity, family income to poverty ratio and, the key exposure of interest to this study, child food security. The Food Security section of the NHANES provides information on both Household and Child Food Security. Since 1999, the NHANES evaluates ***household food security*** using the United States Department of Agriculture (USDA) Food Security Survey Module (Johnson et al., 2014), an 18 questions instrument, based on which the USDA designates households with very low or low food security as being food insecure and households with marginal or high food security as being food secure; approximately 45,000 households participate in the USDA's food security survey each year (USDA, 2018). In the NHANES, the household food security variable has four categories: (1) full food security, (2) marginal food security, (3) low food security, if three or more conditions that indicate food insecurity were reported and (4) very low food security, if five or more conditions that indicate food insecurity were reported, where eating patterns are negatively disrupted and food intake has decreased because there were not sufficient funds to purchase food (CDC, 2016).

Given the existing research on the relationship between children's weight and food security, the following variables were identified for the analyses: (1) sociodemographic variables included; gender, age, and race of the child, (2) the socioeconomic status of the family of each child, measured by the family income to poverty ratio, and (3) other explanatory variables for the outcome, the level of physical activity of each child, for example; ***gender*** was measured as male or female, ***age*** varied between 6 and 12 years old**,** and ***race*** was measured with five categories: (1) Caucasian, (2) African American, (3) Hispanic, (4) Asian, and (5) other or multi-racial. ***Poverty*** was measured by the income to poverty ratio; in NHANES, all values at or above 500% above poverty level are coded as 5. For the purpose of this study, the poverty to income ratio (PIR) was rounded up, yielding four categories (1) below poverty, where the ratio varied between 0 and 1.49 (up to 149% of the poverty level); (2) 1.5 to 2.49 or between 150% and 249% above the poverty level; (3) 2.5 to 3.49 or between 250% and 349% above poverty level; (4) 3.5 and above, or 350% or more above poverty level.

Children's physical activity was measured based on the NHANES question: "During the past 7 days, on how many days was [...] physically active for a total of at least 60 minutes per day?" Respondents' options were coded by day, but for the purpose of this project, the variable was recoded into four groups: (0) never, (1) 1-2 days per week, (2) 3-4 days per week, and (3) 5-7 days per week. As with any secondary studies, the analyses were limited to the variables available from the NHANES 2013-2014.

Results

The total number of children, ages 6 to 12, included in this analysis was 2,898 children, of which 52.4% were boys and 47.6% were girls. Overall, there were 51.5% Caucasian, 13.9% African-American, 24.3% Hispanic, 4.8% Asian, and 5.6% other race/multiracial; 43.2% were between 6 and 8 years of age, 27.2% were 9 or 10-years old, and 29.7% were 11 or 12-years old (Table 1). The average age of children in the groups with a normal/underweight BMI showed that they were slightly younger (mean=8.96, SD=2.02) than the children in the overweight/obese group (mean=9.17, SD=2); although the difference was extremely small, it was statistically significant (t (2881) =2.265, p=.024). Nevertheless, children in the groups with secure food and of the children with insecure food (Table 2) were not significantly different in their age, (t (2881) = 0.405, p=.686); the overall average age was approximately 9-years old with a standard deviation of about 2-years.

The majority of children (73.5%) were active 5 to 7 days per week during the prior month, 14.2% were active 3 or 4 days per week, 8.5% were active one or two days per week, while 3.8% were not active at all. The food security distribution shows that 85% of the children in the sample had full food security; 5.4% had marginal food security, 8% had low food security, and 1.6% had very low food security. The ratio of family income to poverty (PIR) showed that 38.1% of all children were below 149% of the poverty level (with a PIR below 1.5), 18.1% were 150% to 249% above poverty level (PIR between 1.5 and 2.49), and 14.8% were at 250% to 349% above poverty level (PIR between 2.5 and 3.49), while 29% of all families were 350% or more above the poverty level (PIR of 3.5 or greater). The two variables measuring children's weight showed that 17.6% of children were perceived by their parents to be overweight, while 34% of the children were overweight or obese based on the BMI value.

Crosstabulation analysis with Pearson χ^2 tests were conducted to test the association between a child's weight (being overweight or obese based on the BMI value) and food security, age categories, gender, race, physical activity, and the ratio of family income to poverty (Table 1); all tests used a confidence level of 95% and a critical level $\alpha = .05$; p-values below 0.05 indicate statistical significance. A significant association was found between child's weight and food security ($\chi^2(3) = 10.474$, p=.015), race ($\chi^2(4) = 133.372$, p <.001), physical activity ($\chi^2(3) = 70.712$, p <.001), and ratio of family income to poverty ($\chi^2(3) = 20.708$, p < .001); no significant association was found between a child's weight and their gender ($\chi^2(1) = 1.675$, p=.196). Children in the African American, Hispanic, and other/multiracial groups were more likely to be overweight or obese than the Caucasian and Asian children; and, children aged six to eight years were less likely to be overweight or obese than the older children. Children from lower-income families, with an income to poverty ratio below 1.5, were more likely to be overweight or obese than their counterparts; and, children with marginal, low and very low food security were more likely to be overweight or obese than the children with full food security.

Table 1: *Respondents' Characteristics by Child's Weight Based on BMI Categories*

		Total	Child's Weight		χ^2/ t	p
			Underweight or Normal	Overweight or Obese		
Gender (%)	Male	51.3	50.8	52.6	1.675	.196
Race (%)	Caucasian	51.5	55.9	42.8	133.372	**.001**
	African-American	13.9	13.1	15.2		
	Hispanic	24.3	20.4	32.1		
	Asian	4.8	5.4	3.5		
	Other	5.6	5.2	6.4		
Age (years)	*Mean* *SD*	9.03 (2.01)	8.96 (2.02)	9.17 (2.00)	2.265	**.024**
Age (%)	6-8	43.2	44.9	39.6	15.985	**.001**
	9-10	27.2	26.7	28.1		
	11-12	29.7	28.4	32.3		
Physical Activity (%)	Never	3.8	3.1	4.7	70.712	**.001**
	1-2 days	8.5	6.8	11.6		
	3-4 days	14.2	13.1	16.5		
	5-7 days	73.5	77.0	67.2		

Family Income to Poverty Ratio (%)	0.01 – 1.49	38.1	35.1	43.9	78.903	**<.001**
	1.50 – 2.49	18.1	16.9	20.6		
	2.50 – 3.49	14.8	15.7	12.9		
	3.50 – 5 or more	29.0	32.3	22.6		
Food Security (%)	Full/Marginal	85.0	86.4	82.3	10.474	**.015**
	Marginal	5.4	5.3	5.7		
	Low	8.0	6.9	10.1		
	Very Low	1.6	1.4	1.9		

Note: *Bold fonts indicate statistically significant results (α=.05).*

Pearson χ^2 tests were further conducted to test the association between food security (secure vs. insecure) and gender, race, age, physical activity, the ratio of family income to poverty, and the children's weight as perceived by parents and as measured by the BMI (Table 2). A significant association was found between food security and race ($\chi^2(4) = 52.5$, $p < .001$), physical activity ($\chi^2(3) = 13.994$, $p = .003$), and ratio of family income to poverty ($\chi^2(3) = 324.44$, $p < .001$); no significant association was found between a child's food security and gender ($\chi^2(1) = .105$, $p=.745$) and age ($\chi^2(2) = 4.288$, $p=.117$).

Table 2: *Respondents' Characteristics by Food Security Category*

		Total	Food Security		χ^2/ t	p
			Insecure	Secure		
Gender (%)	Male	51.3	53.1	52.3	0.105	.745
Race (%)	Caucasian	51.5	41.0	53.8	52.5	**<.001**
	African-American	13.9	21.7	12.8		
	Hispanic	24.3	31.1	22.9		
	Asian	4.8	1.6	5.0		
	Other	5.6	4.6	5.5		
Age (years)	*Mean (SD)*	9.03 (2.04)	9.07 (1.99)	9.03 (2.05)	0.405	.686
Age (%)	6-8	43.2	40.6	43.3	4.288	.117
	9-10	27.2	30.9	26.2		
	11-12	29.7	28.4	30.5		
Physical Activity (%)	Never	3.8	6.3	3.3	13.994	**.003**
	1-2 days	8.5	8.6	7.5		
	3-4 days	14.2	10.0	14.3		
	5-7 days	73.5	75.2	74.9		
Family Income to Poverty Ratio (%)	3.50 or more	38.1	0.0	35.0	20.708	**<.001**
	0.01 – 1.49	18.1	80.3	36.5		
	1.50 – 2.49	14.8	14.2	14.1		
	2.50 – 3.49	29.0	5.5	14.4		
Child Overweight (%) (Per Parent's perception)		17.6	23.3	17.0	10.16	**.001**
Child Overweight or Obese (%) (Per BMI)		34.0	38.9	32.0	8.016	**.005**

Note: *Bold fonts indicate statistically significant results (α=.05).*

Table 3 reports the results of two logistic regression models that tested the association between children's weight (measured by the two binary variables discussed in the previous section) and food security, while accounting for age, race, physical activity, and the ratio of family income to poverty. For the non-technical reader, the odds ratios (OR) show the likelihood or the probability for an event to occur in one group (numerator) as compared to its counterpart or the reference group (denominator). An OR=1 indicates that the two groups do not differ from each other; this is also true when the p-value for an OR is above the critical value of α=.05. An OR>1, indicates higher chances for an event to occur for the group in the numerator vs. the reference group (RG),

while an OR< 1 indicates lower chances for the event to occur in the group at the numerator vs. the RG. The OR greater than 1 are easier to interpret (ex, OR=1.67 indicates that the group in the odds for the group in the numerator are 67% greater, or 1.67 time higher). Therefore, when the OR<1, we can use the formula 1/OR to ease the interpretation (ex, OR=0.67 indicate that the odds are "less likely" but *how much* less likely is difficult to tell from the OR<1, thus we can flip the ratio by dividing 1 by the OR = 1/0.67= 1.49 to learn that the odds are 49% less likely or 1.49 times less likely).

When the dependent variable was measured based on parental perception or parent being told by a doctor that the child was overweight, the model explained 7.8% (Nagelkereke R^2) of the variation, and correctly classified 82% of cases. Next, when the measure used for child's weight was developed based on the BMI, the model explained 6.2% (Nagelkereke R^2) of the variation, and correctly classified 66.8% of cases.

Table 3: *Regression Coefficients: Relationship between Children Weight and Food Security while Adjusting for Age, Race, Family Income to Poverty Ratio, and Physical Activity*

		Overweight (Per Parent)				**Overweight/Obese (Per BMI)**			
		95% CI				**95% CI**			
		OR	**Lower**	**Upper**	**Sig**	**OR**	**Lower**	**Upper**	**Sig**
Race	Caucasian (RG)				**<.001**				**<.001**
	African-American	1.353	.988	1.851	.059	1.515	1.182	1.940	**.001**
	Hispanic	2.396	1.874	3.063	**<.001**	2.065	1.679	2.540	**<.001**
	Asian	1.197	.694	2.065	.517	1.008	.651	1.562	.970
	Other/Multi-Racial	2.325	1.547	3.493	<.001	1.779	1.242	2.547	**.002**
Age	6-8 (RG)				.083				.312
	9-10	1.135	.879	1.464	.331	1.120	.912	1.376	.278
	11-12	1.326	1.035	1.699	**.026**	1.161	.947	1.423	.152
Physical Activity	Never (RG)				**<.001**				**<.001**
	1-2 days	.711	.419	1.205	.205	1.234	.746	2.042	.413
	3-4 days	.540	.329	.888	**.015**	.697	.434	1.122	.137
	5-7 days	.373	.237	.586	**<.001**	.630	.407	.977	**.039**
Family Income to Poverty Ratio	3.50 or more (RG)				.062				**.001**
	0.01 – 1.49	1.179	.892	1.559	.248	1.216	.972	1.521	.087
	1.50 – 2.49	1.508	1.085	2.095	**.014**	1.624	1.242	2.124	**<.001**
	2.50 – 3.49	.980	.683	1.404	.911	.942	.707	1.255	.683
Food security	Full (RG)				**.008**				.218
	Marginal	.879	.550	1.406	.591	1.022	.703	1.485	.910
	Low	1.454	1.039	2.033	**.029**	1.360	1.015	1.821	**.039**
	Very Low	2.396	1.260	4.554	**.008**	1.188	.638	2.212	.587
Constant		.261			**<.001**	.414			**<.001**

Note: *Bold fonts indicate statistically significant results (α=.05); RG=reference group*

Discussion

The unadjusted logistic regression models, which measured the association between a child's weight and food security without accounting for any other characteristics, yielded an OR=1.605, which was statistically significant at α=.05, and showed that children with low food security were about 60.5% more likely to be overweight or obese, as measured by their BMI, than the children with full food security (RG). In the parent-reported weight unadjusted model, children with very low and low food security were 3.146 and respectively 1.667 times more likely to be overweight than the children with full food security. However, both unadjusted models, no matter which variable was used to measure child's body weight status, showed that children with full food security and children with marginal food security were *not* significantly different in their likelihood to be overweight or obese.

In the model with parent-reported child weight, African-American, Hispanic, and children of other race, including multiracial, were significantly more likely to be overweight than Caucasian children. Hispanic and children of other race, including multiracial, were respectively 2.325 times more likely to be overweight than Caucasians. African-Americans were 35.3% more likely than Caucasian children to be overweight, however, Asian children did not differ in their likelihood to be overweight when compared to Caucasian youth. Similarly, in the BMI model, African-American, Hispanic, and other race, including multi-racial, were more likely to be overweight than Caucasian youth, though some noteworthy differences in racial patterns were observed. African-American children were 51.5% more likely to be overweight than Caucasians, a much larger proportion than the previous model; and other/multi-racial children were 77.9% more likely to be overweight than Caucasians, which was less than the odds ratio for parent-reported weight. Hispanic children in the BMI model were approximately 2.1 times more likely to be overweight than Caucasians, and Asian children's BMI did not significantly differ from Caucasian youth, as was seen in the parent-reported weight sample. Children who were 11 or 12 years old were more likely to be overweight than younger children in the parent-reported weight model, while in the BMI model, there was no significant difference in weight variation among the three age groups.

In the **model with parent-reported child weight**, youth exercising 1-2 days per week did not differ in their weight status from children who reported they never exercised during the week (OR=0.711, p=.205). Children participating in physical activity 3 or more days per week were 1.85 times (computed from OR=0.54 as 1/0.54) less likely to be overweight than children not exercising during the week. Similarly, children exercising 5-7 days per week were 2.68 times (computed from OR=0.373 as 1/0.373) less likely to be overweight than children who do not exercise at all. This result suggests children should exercise at least 3 days per week for a healthy weight.

The odds to be overweight/obese per the BMI model were different when compared to the parent-reported weight model. The BMI model shows that children who exercise less than 5 days per week were not significantly different in their odds to be overweight or obese when compared to those who do not exercise at all ($p>.05$). Further, the OR for the children who exercised 5 or more days per week was OR=0.373, which means that the group who exercised 5-7 days per week were 1.58 times less likely (computed from OR=0.373 as 1/0.373) to be overweight than children not exercising at all. You may recall that the parent-reported weight model showed that they were 2.68 times less likely to be overweight or obese. It is likely that these differences indicate parents' distorted perception of their child's weight, but they might also be explained by the differences in the operationalization of the two binary dependent variables.

Children from families below or at poverty level did not differ in the proportion of overweight children, however, children in families that were 50% to 150% above poverty were 50.8% more likely to be overweight than children below or at poverty level (p=.014) in the parent-reported weight model. A similar, yet stronger trend was noted in the BMI model, where children from families below or at poverty level do not differ in the proportion of overweight children, although children in families that are 50% to 150% above poverty are 62.4% more likely to be overweight than those below or at poverty level ($p<.001$). These findings point to possible gaps in federal nutrition assistance programs for the families with incomes above the federal poverty line, and thus ineligible for aid.

In the model with parent-reported child weight, children with low food security were 45.4% more likely to be overweight than children with full food security, and children with very low food security were approximately 2.4 times more likely to be overweight than children with full food security. In contrast, with the BMI model, only children with low food security are 36% more likely to be overweight as compared to children with full food security, whereas children from full, marginal, and very low food security households did not differ in their weight according to the BMI scale.

Conclusions

In recent years, there has been growing concern that food insecurity and child obesity may be associated with each other. Food insecurity appears to exacerbate existing health disparities. This study used two regression models to examine the potential association between food security and

weight in children of elementary and middle school age: using a parent reported measure and using the BMI, a more objective measure. The results of both analyses support the hypothesis that food security is related to a child's weight. Specifically, the conclusions support the viewpoint that children from low income families are more likely to be overweight or obese, due to food insecurity.

Similar to national averages and data, 18% of the children from the 2013-2014 NHANES survey in our sample were overweight according to the parent-reported weight model (Kral, Chittams & Moore, 2017) whereas over 30% of children were overweight when utilizing the BMI variable. A little under 10% of our sample reported being food insecure, slightly lower than national averages (Kral, Chittams & Moore, 2017). Contradictory to the general consensus of other reports, there was no significant difference by gender, or between age groups in the proportion of food insecure overweight children (Jyoti, Frongillo & Jones, 2005; Jilcott et al., 2011; Kaur, Lamb & Ogden, 2015; Burke et al., 2016; Speirs & Fiese, 2016).

The results support previous findings which showed that African American and Hispanic populations and individuals with financial barriers are more likely to be food insecure and overweight or obese due to inadequate nutrition and exercise (McCurdy, Gorman & Metallinos-Katsaras, 2010; Jilcott et al., 2011; Long et al., 2012; Iriart et al., 2013; Morrissey, Jacknowitz & Vinopal, 2014; Elmes, 2016). The proportion of African American and Hispanic children is greater in the low food security and very low food security categories compared to Caucasian youth. This supports prior research on food insecurity as a structural barrier for minorities and economically disadvantaged families (Iriart et al., 2013; Elmes, 2016; Kern et al., 2017) and a precursor of countless disparities in health.

The negative relationship between physical activity and body weight, identified with the logistic regression, suggests that children who were more physically active during the week - at least three days per week in the parent-reported weight model and at least five times per week in the BMI model- were significantly less likely to be overweight. These results are consistent with previous reports that food insecure youth are significantly more likely to face nutritional and exercise barriers and adversities when compared to food-secure youth (Baer et al., 2018).

Both regression models found that children in families at 150% to 249% above the poverty level, ineligible for food assistance, were significantly more likely to be overweight than those below or at the poverty level. Thus, families in the upper-lower-class and lower-middle-class, ineligible for government assistance, are more likely to experience food insecurity when compared to higher income families or to low-income families that are eligible for food assistance.

Childhood obesity places great risks for adverse developmental and health outcomes. Between 2011 and 2014, obesity prevalence hovered near 17% for children 6-12 years (Ogden et al., 2015; Kral, Chittams & Moore, 2017). As of 2014, an estimated 14% of U.S. households were labeled food insecure (USDA, 2018), with 7.9 million children living with food insecurity. Cost, availability, and nutrition awareness should be considered when new programs and policies with a direct impact on children's health are developed. The cost of healthy foods, such as produce, impacts food security, parents' food purchasing habits, and implicitly children's consumption of healthy foods. Availability of quality foods in low-income neighborhoods is still an issue across the nation, as is the need for education nutrition education in vulnerable populations (Jilcott et al., 2011; Mabli & Worthington, 2014; Morrissey, Jacknowitz & Vinopal, 2014; Elmes, 2016; Nguyen et al., 2017).

The results of this study point to structural discrepancies with federal assistance and the government's role in facilitating many of the existing social imbalances related to food security. Future research should focus on reevaluating SNAP and NSLP eligibility criteria, on assessing the time allocated to physical exercise and health education in public schools, on developing safe neighborhoods conducive to physical activity, and on identifying creative solutions to mitigate the shortage of nutritious foods in lower income neighborhoods. Creating a healthy and safe environment accessible to all children, should be a top priority for local public health and community organizations. Additional localized and national studies could help shine light on the subject in order to push for constructive policy action and change for both schools and communities.

The findings highlight a disconcerting gap in federal aid for food insecure children ineligible for government supported food assistance programs, due to their family's income being above the poverty level, yet not high enough to afford the cost of nutritious foods. The difference in the

proportion of overweight children between the low and very low food security category illustrates the shortcomings of the supplemental nutrition assistance programs. Government assistance programs like SNAP (Supplemental Nutrition Assistance Program) and NSLP (National School Lunch Program) intend to aid those in need, yet how to establish when an individual or family requires service is an extremely complex task to institutionalize, preserve, and evaluate (Jilcott et al., 2011; Elmes, 2016; Kern et al., 2017; Nguyen et al., 2017). Nevertheless, federal poverty guidelines should be revised to prevent childhood obesity and other adverse health outcomes that carry high healthcare costs over the course of their lifetime. Upstream efforts should be made to ensure access to nutritious food, affordable for all families, so that all children grow and prosper into healthy adults.

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