# OBESOGENIC BEHAVIORS, SELF-EFFICACY, AND DEPRESSIVE SYMPTOMS IN AMERICAN INDIAN CHILDREN

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*Background: American Indian (AI) children suffer from high rates of obesity, obesity-related disease, obesogenic behaviors, and depressive symptoms. Objective: Study was designed to determine the associations between depressive symptoms and obesogenic behaviors in school-aged AI children in Oklahoma. Methods: Study design was cross-sectional. Depressive symptoms, beverage intake, fruit and vegetable intake, meal frequency, physical activity, and screen time were self-reported. Results: Mean participant age was 10.5 ± 1.6 years (n = 121); 64% were overweight/obese. Depressive symptoms were associated with dieting and screen time. Conclusion: AI chronic disease prevention efforts will benefit by including measures for depression and associations of obesogenic behaviors and depressive symptoms in treatment planning.*

## INTRODUCTION

American Indians (AI), a widely diverse sub-population consisting of culturally and geographically distinct tribes and nations (Lycett, 2014), suffer from higher rates of type 2 diabetes and cardiovascular disease (Jacobs-Wingo et al., 2016). Even the youngest of this population are known to have these conditions (Wheelock et al., 2016), which are often associated with obesity. Overweight/obesity prevalence in AI children ranges from 20%-63% (Dennison et al., 2015; Tomayko, Weinert, Godfrey, Adams, & Hanrahan, 2016; Zephier, Himes, Story, & Zhou, 2006), compared with the 34% reported from U.S. nationally representative samples (Ogden, Carroll, Kit, & Flegal, 2014). Furthermore, behaviors known to contribute to obesity, like obesogenic behaviors, are more pronounced in AI children. Previously, a group of AI children were shown to have greater consumption of sugar-sweetened beverages and low participation in physical activity (Dennison et al., 2015). Seven-to-thirteen-year-old AI children in Oklahoma consume 309 kilocalories (a basic unit of energy) of sugar-sweetened beverages daily (Dennison et al., 2015), compared with the 178 kcal consumed daily by 2-to-11-year-old non-AI children (Han & Powell, 2013). Participation in adequate physical activity is also lower in AI children, with only 32% of AI children in Oklahoma meeting moderate-to-vigorous physical activity recommendations (Dennison et al., 2015), as compared with 70% in a non-AI population of similar aged children (Fakhouri, Hughes, Brody, Kit, & Ogden, 2013). AI children also participate in approximately 3.7 ± 1.7 hours of screen time per day (Foulds, Rodgers, Duncan, & Ferguson, 2016). This rate is higher than that reported for non-AI children (2.2 ± 0.6 hours; Foulds et al., 2016; Marshall, Gorely, & Biddle, 2006). Approximately 8.6% of Oklahoma citizens self-identify as AI, making Oklahoma the fourth highest state for AI population per capita (Office of Minority Health, 2012), making it an ideal environment for examining obesogenic behaviors in AI children.

In this new research, the authors explore the associations of obesogenic behaviors with measures of self-efficacy and depressive symptoms in a similar group of children. Dietary and physical activity self-efficacy (one's confidence in their ability to make healthy choices) mediates obesogenic behaviors in adults (Boudreaux et al., 2003). Self-efficacy is positively associated with healthy choices concerning diet, physical activity, and screen time (Dennison, Sisson, & Morris, 2016). However, these findings are inconsistent (van Stralen et al., 2011), and other influences, such as depressive symptoms (Castillo, Francis, Wylie-Rosett, & Isasi, 2014), should be considered since self-efficacy is inversely related to depressive symptoms in adults (Konttinen, Silventoinen, Sarlio-Lahteenkorva, Mannisto, & Haukkala, 2010; Steca et al., 2014).

A recent review demonstrated that depressive symptoms are associated with less desirable health behaviors (Dennison et al., 2016). Specifically, higher depressive symptoms have been associated with inadequate fruit and vegetable intake and high intake of energy-dense foods, salty foods, and sweet foods by adolescents (Castillo et al., 2014; Hoare et al., 2014; Jacka et al., 2010). Higher depressive symptoms are associated with decreased moderate and vigorous physical activity participation (Dockray, Susman, & Dorn, 2009; Gray, Janicke, Ingerski, & Silverstein, 2008; Jacka et al., 2010; Motl, Birnbaum, Kubik, & Dishman, 2004; Rothon et al., 2010) and higher screen time in adolescents (Benson, Williams, & Novick, 2013; Castillo et al., 2014). The obesity/depression cycle is acknowledged by clinicians; the American Academy of Pediatrics (AAP) recommends screening children and youth for depression beginning at a BMI percentile of 85 or greater, the level at which overweight classifications begin (Barlow, 2007). It is worth noting that AI youth are more severely afflicted by depression and depressive symptoms (25%; Johnson, 1994; Lemstra et al., 2011; Saluja et al., 2004; Stiffman, Alexander-Eitzman, Silmere, Osborne, & Brown, 2007; Zahran et al., 2005) and have a higher prevalence of depression than the general population (7.5%; Avenevoli, Swendsen, He, Burstein, & Merikangas, 2015).

Several studies have examined the relationship of depressive symptoms and obesogenic behaviors (Benson et al., 2013; Bickham, Hswen, & Rich, 2015; Cao et al., 2011; Castillo et al., 2014; Dockray et al., 2009; Gray et al., 2008; Hoare et al., 2014; Irving, Wall, Neumark-Sztainer, & Story, 2002; Jacka et al., 2010; Johnson et al., 2008; Johnson, 1994; Kann et al., 2000; Kremer et al., 2014; Maras et al., 2015; Motl et al., 2004; Needham & Crosnoe, 2005; Ra & Gang, 2016; Rothon et al., 2010; Schmitz et al., 2002; Serdula et al., 1993; Sun et al., 2005; Wang, Fu, Lu, Tao, & Hao, 2014; Ybarra, Alexander, & Mitchell, 2005; Zahedi et al., 2014; Zahran et al., 2005). However, only one has examined depression and self-efficacy (Castillo et al., 2014), and none have specifically included AI youth. In order to follow the current American Academy of Pediatrics (AAP) recommendations (Spear et al., 2007) and facilitate effective obesity intervention programs targeting vulnerable populations, further exploration of the association of obesogenic behaviors and depressive symptoms' status and self-efficacy in AI children is warranted. The purpose of this study was to determine the relationship between depressive symptoms and obesogenic behaviors and whether self-efficacy mediates that relationship, independent of obesity, in pre-adolescent (7 to 13 years) AI children. We hypothesized that depressive symptoms would be associated with obesogenic behaviors and that self-efficacy would mediate this relationship.

## METHODS

### Study Design

This cross-sectional study was conducted during the first day of a diabetes prevention summer camp, Native Youth Preventing Diabetes (NYPD), in June 2015. Height and weight was measured by trained technicians. Participants completed dietary, physical activity, screen time, dietary/physical activity self-efficacy, and depressive symptoms through self-report surveys. Personnel, including tribal employees and organization volunteers, assisted children with reading survey tools and were trained to avoid leading, social pressure, or directing responses. Approval from the NYPD coalition and the university Institutional Review Board was received before study initiation.

## Population

AI children who attended the NYPD camp were eligible for participation. Participation was not required for camp attendance, and camp recruitment was open to 7- to 13-year-old children affiliated with 13 Oklahoma-based tribes. With one exception, all parents or guardians returned the signed consent form to have their child participate ($n$ = 121). All children with parental consent assented. Children's ages, dates of birth, and sexes were reported by parents or guardians.

## Measures

### Body Mass Index (BMI)

Weight and height were measured using a Tanita TBF-310 Body Composition Analyzer (Tanita Corporation, Arlington Heights, Ill) and a Seca stadiometer (Seca Corporation, Chino, CA), respectively. Participants were measured wearing light clothing and without shoes. Participants' BMIs (wt(lb)/(ht(in))$^2$x703) and percentiles (Kuczmarski et al., 2000) were calculated for age in months and sex (Shape Up America!, 2013). The BMI percentiles were classified as defined by the Centers for Disease Control and Prevention (CDC; Centers for Disease Control, 2013) and collapsed as under/healthy weight (<85$^{th}$ percentile) and overweight/obese ($\geq$ 85$^{th}$ percentile) to describe the sample.

### Depressive Symptoms

Depressive symptoms were assessed using the Child Depression Inventory, a 27-item survey that was previously validated in 6- to 17-year-old children (Cronbach's alpha = 0.86; Saylor, Finch, Spirito, & Bennett, 1984). Survey questions addressed feelings of sadness, self-worth, and depression. Answer options included three responses, with progressively serious indicators of depressive symptoms for each question (i.e., I feel sad some/most/all of the time). Outcomes considered to be of elevated risk were discussed privately with participants. It is important to distinguish between depression and depressive symptoms. For the purpose of this study, these are operationalized as follows: 1) depression is a clinical diagnosis made by mental health professionals who often use various tools to assist in diagnosis, whereas 2) depressive symptoms are a continuous range of symptoms, without an official diagnosis of depression by a mental health care provider, often utilizing clinical tools. Most literature examining depression and obesogenic behaviors has used depressive symptoms rather than including official clinical diagnoses (Dennison et al., 2016). For our purposes, the term depressive symptoms will be used in lieu of a clinical diagnosis.

**Dietary Behaviors**

*Sugar-sweetened Beverage Consumption*

Frequency and volume of sweetened juice/beverages, regular soda, diet soda, sweetened teas, and energy/sports drinks was measured using a modified Beverage Questionnaire-15 (Bevq-15) with moderate-to-strong test/retest reliability ($r^2 = 0.52$-$0.95$, $p < 0.001$; Hedrick et al., 2012). The survey was abbreviated to five questions to make it easier for younger children to understand. Frequency, volume, and type of beverage were used to calculate daily kilocalorie consumption.

*Meal Consumption*

Breakfast, lunch, and dinner consumption frequency was assessed using three items from the Project Eating Among Teens (EAT) survey (DeLong et al., 2008). Response options included "never," "1-2 days," "3-4 days," "5-6 days," and "every day" per week (Cronbach's alpha = 0.57; Neumark-Sztainer, Wall, Perry, & Story, 2003). As reported in a previous study, the median value for each answer option was used to calculate weekly frequency of meals (Larson, Neumark-Sztainer, & Story, 2009). For example, "1-2 days" was calculated as 1.5 days.

*Fruit and Vegetable Consumption*

Fruit and vegetable consumption were assessed using five items from the Youth Risk Behavior Surveillance survey (Kann et al., 2000). Questions assessed the frequency of fruit, salad, potato, carrot, and "other" vegetable consumption. Questionnaire responses included "0 times," "1-3 times during the past 7 days," "4 to 6 times during the past 7 days," "1 time/day," "2 times/day," "3 times/day," and "4 or more times/day." Accuracy and validity values for this survey have not been reported. Consistent with YRBSS methodology (CDC, 2015), the median value for each answer option range was used to calculate daily fruit and vegetable consumption. For example, "1-3 times during the past 7 days" was calculated as 0.28 times in the past 7 days.

### Physical Activity Behaviors

Type and duration of physical activity behavior was evaluated using three items from the Project Eat survey (DeLong et al., 2008). Questions assessed time spent in mild (e.g., slow walking), moderate (e.g., slow bicycling), and vigorous (e.g., running, fast bicycling) physical activity. Questionnaire responses included "never," "less than 0.5 hours/week," "0.5-2 hours/week," "2.5-4 hours/week," and "6+ hours/week." Moderate test-retest reliability has been reported (mild physical activity $r = 0.54$, moderate physical activity $r = 0.53$, and vigorous physical activity $r = 0.72$) for 12- to 18-year-old children (Larson, Neumark-Sztainer, Story, van den Berg, & Hannan, 2011). While this tool has not been validated in younger participants, our previous work with this tool shows no age difference (Dennison et al., 2015). As reflected in the Project EAT instrument development, the median value for each answer option range was used to calculate time spent in physical activity per week. For example, "0.5-2 hours/week" was calculated to be 1.25 hours per week (Project EAT and F-EAT Surveys Psychometrics, n.d.).

### Screen Time Behaviors

Screen time behavior questions from the Project EAT survey assessed time spent watching TV, using a computer, playing sedentary electronic games, and playing non-sedentary electronic games (i.e., exergaming) on weekdays and weekend days (DeLong et al., 2008). Questionnaire responses included "0 hours/day," "0.5 hour/day," "1 hour/day," "2 hours/day," "3 hours/day," "4 hours/day," and "5+ hours/day." Actual values for each answer option were used to calculate screen time. The correlation coefficients of these questions for 12- to 18-year-old children has been reported to be $r = 0.67$ (watching TV/DVD), $r = 0.81$ (using computer), $r = 0.84$ (sedentary video games), and $r = 0.73$ (non-sedentary video games; Project EAT and F-EAT Surveys Psychometrics, n.d.). This tool is not validated in younger participants. However, its length and difficulty are similar to that of the other self-report surveys used in the present study.

### Self-Efficacy

Dietary self-efficacy was assessed using a nine-item assessment tool from the Project Eat Survey (Neumark-Sztainer, Wall, Story, & Perry, 2003) that asks the participant how confident they are to choose healthy foods while in various scenarios. Responses ranged from "not at all sure" to "very sure." The psychometric properties for these questions have not been reported. However, the tool has been used in other studies targeting older children, adolescents, and adults

(Irving et al., 2002; Larson, Neumark-Sztainer, Hannan, & Story, 2007; Larson, Story, Perry, Neumark-Sztainer, & Hannan, 2007; Neumark-Sztainer et al., 2002; Neumark-Sztainer, Wall, Haines, Story, & Eisenberg, 2007; Neumark-Sztainer, Wall, Perry, & Story, 2003). Physical activity self-efficacy was assessed using three items from the Project Eat Survey (DeLong et al., 2008) that determined whether the participant agreed that they could be physically active despite time, weather, and travel constraints. Responses ranged from "agree a lot" to "disagree a lot." Internal consistency of the tool has been tested in children ages 12-18 years (Cronbach's alpha = 0.73; Pearson's *r* value = 0.71; Project EAT and F-EAT Surveys Psychometrics, n.d.). This tool was chosen for its previous use in an AI population (DeLong et al., 2008), ease of administration, and readability. Searches for similar validated tools in a younger population yielded no results before study initiation. Since there is not a congruent measure of screen time self-efficacy and similar to a previous study (Castillo et al., 2014), the physical activity self-efficacy score was used in the fully adjusted screen time linear regression analysis.

### Data Analysis

Descriptive characteristics were calculated for all variables (Table 1). Sex differences in obesogenic behaviors were examined using an independent *t*-test. Individual crude bivariate linear regression models that included each behavioral independent variable and the depressive symptoms dependent variable were calculated (data not presented). Correlations between potential confounders (e.g., age, sex, BMI percentile, behavioral self-efficacy), depressive symptoms, and each obesogenic behavior were calculated. The gender test was performed to determine if sex needed to be included as a covariate. Based on significant correlations and *t*-tests amongst hypothesized confounders and model variables, each bivariate linear regression model (single behavioral predictor and depressive symptom outcome) was adjusted for pertinent confounders. Mediating relationships were calculated using the Sorbel test (Quantpsy.org, 2001). SPSS© version 20 was used for descriptive and regression analyses.

**Table 1**
**Descriptive Characteristics of 7 to 13-year-old AI children (*n* = 121)**

| | % (n) or mean ± SD |
|---|---|
| **Demographics** | |
| Female | 60.3 (73) |
| Male | 39.7 (48) |

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**Table 1 Continued**
**Descriptive Characteristics of 7 to 13-year-old AI children (*n* = 121)**

| | % (n) or mean ± SD |
|---|---|
| **Number of Children by Age (years)** | |
| 7 | 1.7 (2) |
| 8 | 10.7 (13) |
| 9 | 16.5 (20) |
| 10 | 17.4 (21) |
| 11 | 19.8 (24) |
| 12 | 25.6 (31) |
| 13 | 8.3 (10) |
| Mean Age | 10.5 ± 1.6 |
| **Weight Characteristics** | |
| BMI percentile | 80.7 ± 24.2 |
| Underweight/normal weight | 36.3 (44) |
| Overweight/obese | 63.6 (77) |

## RESULTS

The sample consisted of 121 children (60% female) with a mean age of 10.5 ± 1.6 years. Approximately 64% were classified overweight/obese, and 12% met criteria for depressive symptoms. Males consumed more sweet tea, energy/sports drinks, and total sugar-sweetened beverages and spent more time in sedentary video game usage on both weekdays and weekends. Table 2 shows the obesogenic behavior data for total sample, males, and females. Average daily total sugar-sweetened beverage intake for the group was 381.9 ± 248.1 kcal; average daily total fruit and vegetable serving consumption was 1.9 ± 0.9 average daily total moderate + vigorous physical activity time (hours) was 0.7 ± 0.5; and average daily screen time (hours) was 7.2 ± 5.7 (weekday) and 7.3 ± 6.1 (weekend).

**Table 2**
**BMI, Child Depression Inventory (CDI), and obesogenic behavior characteristics (mean ± *SD*) for 7- to 13-year-old AI children (*n* = 121)**

| | Total Sample | Females | Males | *p*-value |
|---|---|---|---|---|
| **CDI Score** | 0.38 ± 0.29 | 0.38 ± 0.30 | 0.37 ± 0.27 | 0.812 |
| **BMI percentile** | 80.7 ± 24.2 | 80.5 ± 25.7 | 80.1 ± 22.0 | 0.929 |
| **Diet Intake Behaviors** | | | | |
| *Daily Sugar-sweetened beverage intake (kilocalories)* | | | | |
| Sweet juice | 102.1 ± 98.4 | 101.7 ± 104.3 | 102.8 ± 89.9 | 0.950 |
| Diet soda | 1.3 ± 1.5 | 1.2 ± 1.4 | 1.4 ± 1.7 | 0.628 |
| Regular soda | 112.5 ± 106.9 | 97.7 ± 93.1 | 135.0 ± 122.7 | 0.077 |
| Sweet tea | 64.8 ± 70.7 | 47.0 ± 55.6 | 91.9 ± 82.2 | **0.001** |
| Energy/sports drinks | 101.4 ± 111.9 | 76.1 ± 86.2 | 139.7 ± 134.7 | **0.005** |
| All sugar-sweetened beverages | 381.9 ± 248.1 | 323.7 ± 207.7 | 470.7 ± 279.0 | **0.002** |

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**Table 2 Continued**
**BMI, Child Depression Inventory (CDI), and obesogenic behavior characteristics (mean ± *SD*) for 7- to 13-year-old AI children (*n* = 121)**

| | Total Sample | Females | Males | *p*-value |
|---|---|---|---|---|
| **Diet Intake Behaviors** | | | | |
| *Daily Fruit/Vegetable Intake (servings frequency)* | | | | |
| Fruit | 1.1 ± 1.4 | 1.0 ± 1.2 | 1.3 ± 1.6 | 0.271 |
| Salad | 0.6 ± 0.9 | 0.6 ± 0.9 | 0.6 ± 1.0 | 0.925 |
| Potato | 0.6 ± 1.0 | 0.6 ± 1.1 | 0.6 ± 0.9 | 0.930 |
| Carrot | 0.7 ± 1.2 | 0.6 ± 1.0 | 1.0 ± 1.4 | 0.105 |
| Other vegetables | 1.1 ± 1.2 | 1.0 ± 1.1 | 1.2 ± 1.3 | 0.426 |
| All fruit and vegetables | 1.9 ± 0.9 | 1.9 ± 0.9 | 2.1 ± 1.0 | 0.338 |
| *Meal Consumption Per Week (frequency)* | | | | |
| Breakfast | 5.1 ± 2.5 | 5.1 ± 2.5 | 5.0 ± 2.6 | 0.740 |
| Lunch | 5.6 ± 2.2 | 5.7 ± 2.1 | 5.5 ± 2.4 | 0.403 |
| Supper | 6.3 ± 1.6 | 6.4 ± 1.5 | 6.1 ± 1.7 | 0.310 |
| All meals | 16.9 ± 5.1 | 0.6 ± 0.1 | 0.6 ± 0.2 | 0.383 |
| *Physical Activity Behaviors (hours per day)* | | | | |
| Vigorous | 0.4 ± 0.3 | 2.9 ± 2.1 | 2.5 ± 2.2 | 0.362 |
| Moderate | 0.3 ± 0.3 | 2.2 ± 2.0 | 2.1 ± 2.1 | 0.789 |
| Mild | 0.3 ± 0.3 | 2.0 ± 2.2 | 1.7 ± 2.1 | 0.462 |
| Moderate + vigorous | 0.7 ± 0.5 | 0.7 ± 05 | 0.7 ± 0.6 | 0.503 |
| **Screen Time Behaviors (hours per day)** | | | | |
| *Weekday* | | | | |
| Watching television/videos | 2.0 ± 1.8 | 2.0 ± 1.9 | 2.8 ± 1.8 | 0.582 |
| Using computer | 0.9 ± 1.6 | 0.7 ± 1.4 | 1.2 ± 1.8 | 0.154 |
| Playing sedentary video games | 1.3 ± 1.6 | 0.9 ± 1.0 | 2.1 ± 2.0 | **<0.001** |
| Playing non-sedentary video games | 1.1 ± 1.5 | 1.0 ± 1.2 | 1.4 ± 1.9 | 0.174 |
| Other electronic device use (tablets, phones, etc.) | 1.9 ± 1.9 | 2.0 ± 1.8 | 1.8 ± 1.9 | 0.496 |
| *Weekend* | | | | |
| Watching television/videos | 2.0 ± 1.8 | 2.1 ± 1.8 | 2.0 ± 1.8 | 0.728 |
| Using computer | 0.9 ± 1.7 | 0.7 ± 1.5 | 1.2 ± 1.9 | 0.103 |
| Playing sedentary video games | 1.3 ± 1.7 | 1.0 ± 1.5 | 1.9 ± 2.0 | **0.008** |
| Playing non-sedentary video games | 1.2 ± 1.6 | 1.0 ± 1.3 | 1.4 ± 1.9 | 0.193 |
| Other electronic device use (tablets, phones, etc.) | 1.9 ± 1.9 | 2.1 ± 1.9 | 1.6 ± 1.7 | 0.170 |
| Total screen time per average weekday (hrs) | 7.2 ± 5.7 | 6.5 ± 4.7 | 8.5 ± 6.9 | 0.079 |
| Total screen time per average weekend day (hrs) | 7.3 ± 6.1 | 6.8 ± 5.4 | 8.1 ± 7.0 | 0.295 |

Correlational analysis (not shown) showed associations between age and sports drinks, other vegetable intake, vigorous physical activity, weekday and weekend television use, and other electronic device use. Sex was correlated with sweet tea, energy/sports drinks, total sugar-sweetened beverage intake, and weekday/weekend sedentary video game use. Table 3 displays the results of the adjusted linear regression models for the sample. When adjusted for potential confounders, as identified in correlational analysis (see table 3 subscript), higher depressive symptoms were associated with higher diet soda intake and lower breakfast, lunch, and supper frequency. There was no association between depressive symptoms and frequency of fruit and vegetable consumption or hours spent in physical activity. Regarding screen time, depressive symptoms were associated with one weekday behavior and several weekend behaviors. Higher depressive symptoms were associated with more hours per weekday of "other" electronic use. In addition, higher depressive symptoms were associated with more hours per weekend day spent watching television/videos, using a computer, playing sedentary video games, "other" electronic use, and total hours of screen time. Dietary and physical activity self-efficacy were not mediators in the relationship between depressive symptoms and obesogenic behaviors.

**Table 3**
**Adjusted association between BMI and obesogenic behaviors and depressive symptoms in 7- to 13-year-old AI children ($n$ = 121)**

| Predictor Variable | Beta + SE (Unstandardized) | p-value |
|---|---|---|
| **BMI Percentile** | 0.001 ± 0.001 | 0.305 |
| **Dietary Intake Behaviors** | | |
| *Daily Sugar-sweetened Beverage intake (kilocalories)* | | |
| Sweet juice | 0.000 ± 0.000 | 0.761 |
| **Diet soda** | **0.044** ± 0.017 | **0.012** |
| Regular soda | 0.000 ± 0.000 | 0.373 |
| Sweet tea [c] | 0.000 ± 0.000 | 0.569 |
| Energy/sports drinks [a, c] | 0.000 ± 0.000 | 0.282 |
| All sugar-sweetened beverage intake [c] | 0.000 ± 0.000 | 0.349 |
| *Daily fruit/vegetable intake (servings frequency)* | | |
| Fruit | -0.024 ± 0.019 | 0.213 |
| Salad | -0.026 ± 0.028 | 0.347 |
| Potato | -0. 006 ± 0.025 | 0.818 |
| Carrots [b] | -0.041 ± 0.023 | 0.075 |
| Other vegetables [a, b] | -0.007 ± 0.023 | 0.750 |
| All fruit and vegetable intake | -0.050 ± 0.029 | 0.081 |
| *Meal consumption per week (frequency)* | | |
| Breakfast | **-0.038** ± 0.010 | **<0.001** |
| Lunch | **-0.030** ± 0.012 | **0.012** |
| Supper | **-0.048** ± 0.016 | **0.003** |
| All meals | **-0.020** ± 0.005 | **<0.001** |
| *Physical Activity Behaviors (hours per day)* | | |
| Vigorous [a, e] | -0.058 ± 0.084 | 0.491 |
| Moderate [b, e] | 0.054 ± 0.087 | 0.537 |
| Mild | 0.001 ± 0.012 | 0.952 |
| Moderate + vigorous [e] | -0.005 ± 0.048 | 0.918 |
| **Screen Time Behaviors (hours per day)** | | |
| *Weekdays* | | |
| Watching television/videos [a, e] | 0.007 ± 0.015 | 0.653 |
| Using computer | 0.032 ± 0.017 | 0.055 |
| Playing sedentary video games [c, e] | 0.008 ± 0.017 | 0.655 |
| Playing non-sedentary video games | 0.013 ± 0.017 | 0.444 |
| Other electronic device use (tablets, phones, etc.) [a, e] | **0.030** ± 0.014 | **0.034** |
| Total screen time per weekday [e] | 0.007 ± 0.004 | 0.090 |

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**Table 3 Continued**
**Adjusted association between BMI and obesogenic behaviors and depressive symptoms in 7- to 13-year-old AI children (*n* = 121)**

| Predictor Variable | Beta + SE (Unstandardized) | p-value |
|---|---|---|
| **Screen Time Behaviors (hours per day)** | | |
| *Weekend Days* | | |
| Watching television/videos [a] | **0.036** ± 0.015 | **0.014** |
| Using computer | **0.037** ± 0.015 | **0.019** |
| Playing sedentary video games [c, e] | **0.032** ± 0.015 | **0.033** |
| Playing non-sedentary video games | 0.020 ± 0.016 | 0.236 |
| Other electronic device use (tablets, phones, etc.) [a, b, e] | **0.029** ± 0.014 | **0.043** |
| Total screen time per weekend day [e] | **0.010** ± 0.004 | **0.009** |

SE = standard error. Specific pertinent covariates were determined by *t*-test (gender) and correlation and are identified by superscripts. Models without superscripts did not have any significant correlations or *t*-test differences. Bolded values indicate statistical significance ($p < 0.05$).
Adjusted for: [a] age, [b] BMI %ile, [c] sex, [d] dietary self-efficacy, [e] physical activity self-efficacy

## DISCUSSION

The primary findings of this project have been previously supported in the literature and include the significant relationships observed between depressive symptoms and obesogenic behaviors, such as diet soda consumption (Fowler, 2016), meal skipping (Fulkerson, Sherwood, Perry, Neumark-Sztainer, & Story, 2004), and certain screen time variables (weekday "other" electronic use and weekend TV/video, computer, sedentary video games, "other," and total screen time use (Bickham et al., 2015). Of equal importance is the absence of significant relationships between depressive symptoms and BMI percentile, sugar-sweetened beverage intake, fruit and vegetable intake, and physical activity. Contrary to previous reports (Boudreaux et al., 2003; Konttinen et al., 2010; Steca et al., 2014), self-efficacy was not a mediator in the relationships between depressive symptoms and obesogenic behaviors. The younger age of the population may have contributed to this outcome, as younger children have diminished control of their obesogenic behavior decisions. Self-efficacy may also be less of a contributor in the AI population due to inherited feelings of historical trauma that result in diminished personal confidence (Kirmayer, Gone, & Moses, 2014).

The prevalence of overweight/obesity in this sample of AI children was 60%, which is higher than national reports (17%; Ogden, Carroll, Kit, & Flegal, 2014) but lower than a similar study conducted by our team in 2013 (63%; Dennison et al., 2015). Consistent with previous reports (Saluja et al., 2004; Stiffman et al., 2007), depressive symptoms were higher (12%) than found in a nationally representative sample (3%; Halfon, Larson, & Slusser, 2013). Compared with this sample (382 kcal per day), 309 kcal per day was previously reported as daily sugar-sweetened beverage kcal intake in a similar population, with the biggest difference in energy/sports drink consumption (57 kcal vs. 102 kcal; Dennison et al., 2015). Fruit and vegetable intake in this sample was 1.9 servings per day. This intake is substantially below the 5 per day recommendation (Guenther, Dodd, Reedy, & Krebs-Smith, 2006) and earlier reports of nationally representative data (3.4-3.8 servings per day) with children of similar ages (Guenther et al., 2006). Time spent in moderate/vigorous physical activity was 0.7 hours/day, which is more than previous reports in a similar population (0.6 hours per day; Dennison et al., 2015) and national recommendations of one hour per day of moderate-to-vigorous physical activity (Kirschenbaum & Gierut, 2013). Screen time for this population was 7.2-7.3 hours per day (weekday, weekend), which is higher than previous reports in a similar population (4.8 hours per day; Foulds et al., 2016), higher than reported in non-AI children (3.2-3.9 hours per day; Foulds et al., 2016; Marshall et al., 2006), and higher than the recommendation of <2 hours per day (Kirschenbaum & Gierut, 2013).

Similar to a previous report, diet soda and meal intake frequency were positively associated with depressive symptoms (Dennison et al., 2016). Meal skipping may be a function of a heightened awareness of obesity-related chronic diseases in this population and subsequent inappropriate actions to prevent them, similar to disordered eating. Within the younger participants of this age group, meal skipping may be a function of the absence of food or regularly timed meals in the home as opposed to an intentional choice to avoid a meal. Well-intended, but misconstrued, nutrition education directed at this population may drive restrictive eating practices by over-emphasizing foods to be avoided and under-emphasizing foods that should be encouraged (Schlundt, Rowe, Pichert, & Plant, 1999).

No physical activity variables were associated with depressive characteristics. The existing literature regarding the relationship between depressive symptoms and physical activity is inconsistent. Some studies demonstrate no relationship between depressive symptoms and physical activity (Hoare et al., 2014; Johnson et al., 2008; Maras et al., 2015; Schmitz et al., 2002), while others indicate that higher physical activity is associated with lower depressive symptoms (Cao et al., 2011; Castillo et al., 2014; Kremer et al., 2014; Rothon et al., 2010). Since AI children have a higher risk for depressive symptoms (Johnson, 1994; Lemstra et al., 2011;

Saluja et al., 2004; Stiffman et al., 2007; Zahran et al., 2005) than do non-AI children, physical activity may have a blunted effect in decreasing the symptoms of depression in this population.

The relationships between screen time and depressive symptoms are more consistent than with other obesogenic behaviors examined. However, we observed differences between weekday and weekend screen time. More weekend screen time variables were significantly associated with depressive symptoms than weekday screen time variables, with the exception of weekday "other" electronic use. This may be due to the propensity for "other" electronic use to be related to social media, in which relationships are found to be more isolating and less satisfactory than face-to-face relationships (Bickham et al., 2015). Depressive symptoms and weekend screen time associations may be a result of similar circumstances where routine peer face-to-face interactions are absent on the weekends. Depressive symptoms also drive the use of "other" electronics as a coping or "escape" mechanism (Bickham et al., 2015). "Other" electronic use, which includes tablet and mobile phone use, are primarily used for texting and accessing social media sites (Reid Chassiakos, Radesky, Christakis, Moreno, & Cross, 2016) and have been shown to contribute to depressive symptoms through cyber-bullying and disconnectedness as previously described (O'Keeffe & Clarke-Pearson, 2011).

The absence of a significant mediation between depressive symptoms and self-efficacy in diet, physical activity, and screen time is noteworthy. Due to the lack of validated screen time self-efficacy assessments and particularly the use of a physical activity self-efficacy assessment tool in this sample, broader interpretations of this finding are difficult. BMI percentile was not found to be associated with depressive symptoms or the relationship between depressive symptoms and obesogenic variables, a finding that is similar to a report regarding overweight/obese children seeking weight management treatment (Benson et al., 2013). This further highlights the need for in-depth pediatric clinical assessments for both depression and obesogenic behaviors, regardless of BMI status in AI children, as both of these risk factors (depressive symptoms and obesogenic behaviors) are more prevalent in this population.

**Strengths/Limitations**

One of the unique aspects of this study, and an important contribution to the literature, is the focus on AI children and youth, a population historically resistant to scientific examinations and at elevated risk for disease. While the AI population as a whole is diverse, the inclusion of participants who originate from Oklahoma lends to generalizability for AI children in Oklahoma. The cross-sectional nature of this study does not allow for trend or intervention analysis. While no body weight guidelines were used in recruitment for the NYPD camp, parents may have been more likely to send their children, and participate in the study, if they perceived their child was more at-risk for obesity or type 2 diabetes development. Tools used were validated in the pediatric population, thus strengthening findings; however, some of the tools were not validated in the youngest members of this population. As with any study, accuracy is questionable in self-report questionnaires. However, all precautions to include appropriate tools and professional oversight were employed to reduce inaccurate responses. While the study size was relatively small, the participants resided in both rural and urban areas, which provided better generalizability to the Oklahoma AI population. However, caution would be prudent in generalizing these findings to other populations. This study would have been strengthened by the addition of biometric values, including glucose, lipid, and blood pressure measurements that provide downstream outcomes of obesogenic behaviors and signify the presence of chronic disease. The addition of parental obesogenic behavior assessment would also provide insight into participant health choices.

## Clinical Applications

Given the findings of this study, some applications can be made for clinicians working with this population in a mental or physical health capacity. A counter-balance to increased restrictive eating as a result of diet education oversaturation may be an adjustment in practice recommendations to highlight foods that should be included, instead of what should be avoided. This information may also alert clinicians to the need for depression screening in the presence of patient diet restriction. As shown in previous reports (Kremer et al., 2014), the authors believe that a decrease in sedentary screen time and increase in physical activity in this population will lead to healthy socialization and an improvement in depressive symptomology. This information can lead educators in emphasizing reduced non-social screen time for both depressive symptom prevention and obesogenic behavior control. Although not examined in this study, it is likely that parental involvement in encouraging healthy food intake (ensuring healthy foods are available) and reducing screen time (setting healthy limits) should be considered in practical applications.

## CONCLUSION

In summary, these findings highlight the need for obesity prevention in AI children and emphasize the significance of depressive symptoms in obesity development. This study also shows that some obesogenic behaviors, specifically diet soda intake, meal skipping, and screen time variables, are associated with depressive symptoms. Concepts that would expand the utility of this study and further the efforts to prevent and slow the progression of chronic disease in this population include biometric considerations. The addition of biometric values to this study would provide valuable outcomes that result from obesogenic behaviors and depression. Biometric values that would enhance these outcomes include blood glucose, blood pressure, and blood lipids, as these indicators are often associated with chronic disease development.

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