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Introduction

Nature of the research problem

In the last several decades, there has been a growing recognition by health professionals that obesity is a major public health problem, particularly among racial/ethnic minority populations in the United States (Hedley et al., 2004; Ogden et al., 2006; Rosen-Reynoso, Alegria, Chen, Laderman, & Roberts, 2011; Scharoun-Lee, Kaufman, Popkin, & Gordon-Larsen, 2009). Further, the prevalence of obesity among children has been escalating (Bandini, Curtin, Hamad, Tybor, & Must, 2005; Hedley, et al., 2004) with some reports that it has tripled among school-age children and adolescents in the past 20 years, and remains high at approximately 17% (Curtin, Anderson, Must, & Bandini, 2010; Ogden, et al., 2006; Ogden, Carroll, Kit, & Flegal, 2012). Up until recently, researchers’ endeavors to document accurate prevalence rates and to identify strategies to reduce obesity among children and adolescent populations have primarily focused on those without special health care needs (Safron, Cislak, Gaspar, & Luszczynska, 2011; Sallis & Glanz, 2006), with limited investigation of interventions for children with special health care needs (Hinckson, Dickinson, Water, Sands, & Penman, 2013). This has led to a substantial gap in our knowledge of obesity among children and youth with special health care needs (SHCN). There is evidence that obesity rates among children with SHCN (especially certain types of conditions) is higher than for their peers without special health care needs (Bandini, et al., 2005; Curtin, et al., 2010; Reinehr et al., 2010; Rimmer, Rowland, & Yamaki, 2007). For children with SHCN, obesity is not only a risk factor for chronic conditions such as hyperlipidemia and Type II diabetes, but it also presents a greater risk for developing secondary conditions associated with their primary condition (Liou, Pi-Sunyer, & Laferrère, 2005).

Brief overview of relevant background literature on children with special health care needs

Reinehr and colleagues (2010) state that the disparity in obesity rates between those with and without disabilities is apparent from as early as 3 years of age and this trend continues into adulthood. Studies focusing on adolescents with disabilities have shown that obesity has increased the risk for certain conditions such as: dyslipidemia and hypertension (Buffart, Roebroeck, Rol, Stam, & van den Berg-Emons, 2008). However, obesity for this group primarily represents a crucial risk factor for the development and/or deterioration of secondary conditions arising from the underlying disability, including: fatigue, chronic pain from joints and muscles leading to impaired mobility (Rimmer, et al., 2007). In addition, this can lead to increased social isolation that can result in depression (Liou, et al., 2005). All of these chronic and secondary sequelae of obesity in adolescents with disabilities can lead to a loss of their existing independence and further restrict options for exercise, leisure activities, and employment (Simeonsson, McMillen, & Huntington, 2002). As a result, the quality of life for adolescents with disabilities, which is already lower than their nondisabled peers (Buffart, et al., 2008), is reduced even further. Onset of type 2 diabetes is one of the most common risks of obesity, which can lead to serious lifelong complications (CDC, 2011). Obesity is a significant and prevalent health condition among adolescents with disabilities.
and can lead to further complications that arise from the disability itself with an ultimate impact on their quality of life.

In addition, potential for school success is compromised for children with special health care needs due to emotional, behavioral, or developmental problems, complexity of care needs, and case management in schools (Bethell et al., 2012). Academic disparities in math and language arts begin as early as 4th grade for students who are overweight and have limited fitness (London & Castrechini, 2011). Obesity has been found to be risk factor for poor academic performance through higher rates of absenteeism (Li et al., 2012) and lower grades (Florin, Shults, & Stettler, 2011). Disparities in chronic physical and mental health conditions exist for racial and ethnic minorities that are related to social, emotional, and academic disparities (Graham, 2011). There is no dispute that students with mental health problems are more likely to do poorly in school compared to peers without such problems (Bagdi & Vacca, 2005; Dyregrov, 2004). New evidence using nationally representative samples are beginning to further expand our knowledge of these associations. School dropout rates for a representative sample of emerging adults were over twice the odds for those who had experienced childhood trauma, as mediated by substance abuse and conduct disorder (Porche, Fortuna, Lin, & Alegria, 2011).

The importance of physical activity as a protective factor for mental health (Paluska & Schwenk, 2000), physical health and management of chronic illness (Marrone et al., 2009; Tercyak & Tyc, 2006), and academic performance (CDC, 2010; Efrat, 2011) is emerging as a critical area of study. Numerous school-based interventions have been developed to improve health outcomes, and while outcomes have been promising the understanding of mechanisms requires further study (Demetriou & Höner, 2012; Erwin, Fedewa, Beighle, & Ahn, 2012). Less studied is the impact of physical activity on disabled children who are overweight or obese (Reinehr, et al., 2010; Rimmer & Rowland, 2008; Rimmer, et al., 2007).

**Specific concerns for children with autism spectrum disorders**

Although there are numerous efforts to address pediatric obesity in the United States, little research has been conducted to understand this disease among children with neuro-developmental disorders, including children with autism spectrum disorders (ASD). This specific group of children may be particularly vulnerable to obesity due to the behavioral, physical, and psychosocial complications related to this condition (Dreyer Gillette et al. 2015; Newschaffer et al. 2007) and due to the medications that are often used to treat these children (Maayan and Correll 2011).

In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association 2013), the diagnosis of Autism Spectrum Disorders (ASD) subsumes what the DSM IV previously classified as four separate disorders: autistic disorder, Asperger’s disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified. Individuals who are included as autism spectrum are characterized on a continuum as exhibiting a range of symptoms that include communication deficits,
sensitivity to changes in their environment, intense focus on inappropriate items, restricted,
repetitive, and stereotyped patterns of behavior or are overly dependent on routines
(American Psychiatric Association 2013). The DSM-5 Autism work group recommended that
using the single umbrella disorder would improve the diagnosis of ASD without limiting the
sensitivity of the criteria, or substantially changing the number of children being diagnosed.
The estimated prevalence of ASD is 1 in 68 children (Autism and Developmental Disabilities

According to several studies that analyzed large national datasets, obesity is common
among autistic children (Broder-Fingert et al. 2014; Chen et al. 2010; Curtin et al. 2010). A
2013 clinical study found that almost 22% of children with autism are obese, compared to
the general population rate of 18% (Egan et al. 2013). In a retrospective analysis of
electronic medical record data collected on children with ASD, researchers found a
significantly higher odds of overweight and obesity for children with ASD (Broder-Fingert et
al. 2014). Using national data from 2003 (Chen et al. 2010), researchers examined
prevalence rates of obesity among children with chronic conditions, and among those with
developmental conditions; children with autism had the highest adjusted prevalence of
obesity (23.4%). Thus, the co-occurrence of both ASD and obesity represents an important
public health issue.

Children with ASD often have gastrointestinal problems (Horvath and Perman 2002;
Maenner et al. 2012), feeding problems and nutrient deficiencies (Sharp et al. 2013);
selective eating patterns and food idiosyncrasies (Zimmer et al. 2011; Evans et al. 2011;
Bandini et al. 2010); and are less physically active than their peers without ASD (Hinckson et
al. 2013; Rimmer et al. 2010). In addition, many children with ASD are prescribed
antipsychotic medications that are linked to weight gain (Calles 2011; Kaplan and
McCracken 2012; Nazeer 2011). Clearly, there are numerous factors that may make obesity
prevention or weight reduction interventions that are effective with typically developing
children not applicable to children with autism.

Therefore, one aim of the present study is to examine a nationally representative data from
the National Survey of Children’s Health (NSCH 2011-12) in order to: (a) estimate the
prevalence of obesity in children with autism and investigate potential factors associated
with obesity in children with ASD, including gender, age, race, household income, and
insurance type; and (b) discuss suggestions for future research regarding the prevention
and reduction of obesity in this population.

Summary of purpose, scope, and methods of the investigation

A secondary data analysis of the 2012 National Survey of Children’s Health (NSCH) was
used to investigate prevalence of co-morbid chronic physical and mental health care
conditions associated with risk of obesity and poor academic performance. Physical activity
is tested as a mediator, as it can be intervened on to promote health and well-being. This
investigation responds to MCH Research Issues II and IV by examining the complex
relationship between these factors for diverse populations, this project will yield evidence-based recommendations for the health development of MCH populations. It also responds to Healthy People 2020 Goals including disability and secondary conditions, mental health, overweight, and physical activity, with attention to social determinants of health.

These associations were modeled for a subset of the sample with data on body-mass index (BMI): children and youth ages 10 to 17 years old (n = 43,864). Over 16% of the sample children are identified with complex chronic health care needs. Of these, 18% are identified as overweight and 21% are identified as obese. Over a third of children with special health care needs have emotional, behavioral or developmental issues, and those children are at greater risk for obesity (39% vs. 33%). Analyses will allow comparisons on obesity risk and school outcomes for children with co-morbid special health care needs and those without, and will explore ethnic and racial disparities.

The theoretical framework for this study is the Health Equity model for health that integrates principles and practice of social justice, social capital, human rights and health-equity ethics (Goldhagen, 2007). It is an emerging model for health that provides a blueprint for restructuring our approach to health and wellness that is relevant to the prevention and treatment of obesity. The health problem of obesity has been approached with a classical biomedical model in which obesity is conceptualized as a result of food choice and genetics. However, the socio-economic, political, environmental and cultural determinants of obesity have often been overlooked. As such, a relevant and effective response to obesity (especially for children and adolescents with disabilities), should be a health equity model that includes the community and culture.
Study Design and Methods

Brief Description of Study Design

For this secondary data analysis study, we analyzed data from for a subset of the sample that have data on body-mass index (BMI): children and youth ages 10 to 17 years old (n = 43,864). Almost 20% of the sample are identified with special health care needs. Of these, 17% are identified as overweight and 19% are identified as obese. Obesity rates are higher for children with emotional, behavioral or developmental issues (22%). Analyses tested comparisons on obesity risk outcomes between children with special health care needs and those without, and explored obesity disparities specifically for Hispanic (22%) children.

Population Studied, Sampling, and Recruitment

Sample. The 2012 National Survey of Children’s Health (NSCH) is a cross-sectional study of 95,677 children from all 50 states and the District of Columbia. The NSCH was primarily designed to examine children’s health and well-being by collecting extensive data on physical and mental health status, access to quality health care, and information on the child’s family, neighborhood, and social context. Data describing family processes in attaining health care for their children, neighborhood and community safety, and school environment provide an important context for understanding children’s health and well-being outcomes. Childhood health variables are captured across family types, economic backgrounds, race/ethnicity and geographic regions of residence. Random household sampling was conducted using the State and Local Area Integrated Telephone Survey (SLAITS) and for the second time includes data gathered by cell phones. The 2012 survey differs from the previous surveys, with additional special health care conditions included, questions of activity and functional limitations of children with special health care needs (SHCN), school engagement, and neighborhood supports. Ninety-five percent (95%) of the interviews were conducted in English; the rest were conducted in Spanish or in one of several Asian languages.

Instruments used

Dependent Variables

Overweight and Obesity. Body-mass index (BMI) is obtained from parent report of the child’s height and weight for a categorical measure of BMI for age with overweight indicated for the 85th to 94th percentile (15.6% of sample) and obese for children in the 95th percentile and above (15.7% of sample). The categories take into consideration age and gender. Several recent studies support the reliability of parent report of children’s weight and physical activity across diverse racial and ethnic groups (Moreno et al., 2011; Rosenberg et al., 2010).

Academic Performance Measures. Although school-based records are not available, parent reports include a number of indicators of academic performance, activities, and attitudes.
• Promoting School Success Index is a dichotomous composite variable that includes questions about school engagement, participation in extracurricular activities, and perceived safety at school; the variable indicates whether the child meets criteria or not for promotion of school success; 48% of Black and Hispanic children did not meet the criteria.

• Retention in grade: whether and when a child has every repeated a grade in school (9%).

• Number of days of school missed because of illness or injury (18% missed 6 or more days).

• Number of times parent was contacted in past 12 months about problems at school.

• IEP indicates whether the child has an Individualized Education Program (11%).

• Indicators of school-related practices that are critical for academic success include: “does all homework” on a 5-point scale from never (1) to always (5); and “number of minutes spent reading for pleasure on an average weekday”.

• Intrinsic motivation for academic success is measured by “cares about doing well in school” on a 5-point scale from never (1) to always (5).

**Independent Variables**

**Special Health Care Needs.** The five-item CSHCN Screener, developed by the Child and Adolescent Health Measurement Initiative, was used to identify children with special health care needs. The screener is non-condition specific and uses consequences-based criteria. Children identified as CSHCN experience “one or more current functional limitations or service use needs that are the direct result of an on-going physical, emotional, behavioral, developmental, or other health condition”; 20% of the sample meet this criteria.

• **Data on prevalence (parent ever told by provider that child has condition) and severity for 16 chronic health conditions (with prevalence noted) include:** ADHD/ADD (8%); Anxiety (4%); Asthma (9%); Autism Spectrum Disorder (2%); Brain injury or concussion (<1%); Behavioral or conduct problems 3%; Cerebral Palsy (<1%) Depression (2%); Developmental delay (4%); Diabetes (<1%); Hearing problems (1%); Joint, bone, or muscle problems (2%); Learning disability (8%); Epilepsy (<1%); Stuttering, stammering, or speech problems (5%); Tourette Syndrome (<1%); and Vision problems (1%).

Autism Identification: In the 2011-12 NSCH survey, interviewers asked parents and guardians whether their children (ages 2-17) had ever been diagnosed with Autism, Asperger’s, pervasive development disorder (PDD), or other autism spectrum disorder (ASD), and if so, whether they currently had the condition. We classified subjects as having autism if the parent reported that the child currently had autism for the purposes of our analysis. Using this classification, autism was coded as a dichotomous variable with “Yes” and “No” distinctions.

Based on associations with autism and obesity in literature reviews, we also tested current medication use for “problems with emotions, concentration, or behavior” was included as a dichotomous variable (1=yes, 0=no).

Child mental health status was calculated by summing up the total number of reported mental health diagnoses of four conditions: attention-deficit or attention-deficit/hyperactivity disorder
(ADD or ADHD), depression, anxiety problems, behavioral or conduct problems (values ranged from 0-4; 13.6% of the sample reported one or more diagnoses.

An adapted version of the Adverse Childhood Experiences (ACE) scale (Felitti et al., 1998) were included in the 2012 survey; these variables are associated with risk for physical and mental health disorders and were used to test the impact of trauma exposure on children’s academic, mental health, and physical health functioning. Five items from the original ACE (Felitti et al., 1998) include childhood exposure to divorce/separation, parental incarceration, domestic violence, parental mental health concerns, and parental substance use. A Technical Expert Panel developed four additional questions: socioeconomic hardship, death of a parent, exposure to neighborhood violence, and racial/ethnic discrimination. The total number of adverse childhood experiences (0-9) was included in the analysis. Over half of parents (53.4% weighted) reported that their child had one or more adverse family experiences. For the group of children with any reported adversity, the average number of experiences was 2.09 (+ se .02 [95% CI 2.05,2.12] weighted) adversities, with a full range of 1 to 9.

**Mediating/Moderating Variables**

Physical activity was tested using several measures including: activity limitations which describes how often and how much health conditions affect daily activities on a 3-point scale; participation of extracurricular sports activities, team sports or lessons during out of school time (Yes/No); the number of days in the past week of “exercise, sport, or physical activity for at least 20 minutes that made child sweat and breathe hard”.

**Child and Family Characteristics.** Child characteristics include: ethnicity (Hispanic or not) and Race in three categories: White, Black, and Other (American Indian and Asian categories were also included but only surveyed in selected states); child gender; age in full years; functional limitations; and language spoken in the home.

- Depending on the analysis, one of two variables was included: (1) Mother’s mental health rating on a 5-point scale (1=excellent; 5=poor), as poor caregiver mental health can have an impact on caregiving; or (2) Mother’s physical and mental health rating on a 5-point scale (1=excellent; 5=poor). These variables were either used as originally coded or recoded (using NSCH coded Indicator 6.3) to health as “One or both NOT excellent/very good” vs. “Both are excellent/very good”.
- Family structure is categorized as biological or adopted; 2 parent stepfamily; single mother; other family structure.
- Family characteristics related to health care include insurance coverage for the child.
- Child’s sedentary activity is noted in Health People 2020 as detrimental to physical activity. Thus for these analyses we included hours of electronic device use (computers, cell phones, handheld video games, and other electronic devices, doing things other than schoolwork) reported based on average weekday estimates in hours.

**Neighborhood Characteristics.** Neighborhood safety was measured by report of whether the family “lives in safe community”; the 4-point scale response was recoded to a dichotomous “never/sometimes” or “always/usually” safe.
Control Variables

Child race and ethnicity was coded into four categories: White, Black, Latino, and Other, which were entered as dummy variables with White as the reference. American Indian and Asian categories were included in the survey only in selected states, thus are unavailable for group-level analysis.

Type of insurance coverage was coded into dummy variables as uninsured, public, or private (reference).

The poverty level for the family was based on DHHS Poverty Guidelines in four categories ranging from at or below 100% of poverty (reference) to 100-199% poverty level, 200-399% poverty level, and above 400% poverty level.

Current medication use for “problems with emotions, concentration, or behavior” was included as a dichotomous variable (1=yes, 0=no).

Statistical techniques employed

Analysis
We examined the bivariate associations (using simple logistic regression for categorical variables and simple linear regression for continuous variables) between the predictor and outcome variables using SAS Version 9.4. We used survey-specific SAS procedures (PROC SURVEYFREQ, SURVEYLOGISTIC, and SURVEYREG) to account for the complex study design of the NSCH and to generate estimates that were representative of non-institutionalized children in the US. Because our analysis was focused on the subgroup of children between the ages of 6 and 17, we used the appropriate options (e.g., the DOMAIN option in PROC SURVEYREG) to estimate the correct standard errors for the analytic sample.

For the analyses investigating risk for children with autism spectrum, and for tests of groups differences for Latino children, we conducted descriptive analyses to determine prevalence rates of dependent and independent variables. Chi-square test and multivariate logistic regression modeling were used to assess associations between the independent variables and obesity status. Interaction tests were conducted to assess whether demographic characteristics moderated associations with BMI. Analyses were conducted with Stata 11.0 SE software (StataCorp 2009) using sample weights to adjust for the complex survey design.

Descriptive statistics were computed and prevalence rates were be calculated for the most common co-morbid physical and mental health needs noted in the literature (i.e., asthma and anxiety, diabetes and depression), as all children with co-morbid special care needs (SHCN) are identified for the analysis. Chi-square tests were conducted to analyze group differences for SHCN and typically developing children in the sample. SEM (Muthén & Muthén, 2007) was used to fit path models of observed variables, to test the hypothesis that electronic game use, community safety, age, and gender would be associated with obesity and mediated by physical
activity. The public dataset includes imputed data for household income level used to construct the poverty level variables; any other missing data for this analysis was handled by listwise deletion.

The path model was estimated using Mplus Version 7.31. Approximately 3% of the children were missing values on any of the predictors in the model. Mplus allows for the inclusion of participants with missing data by using full information maximum likelihood (FIML) estimation (Enders, 2010; Muthen & Muthen, 1998-2012), drawing on the theory by Little and Rubin (1987). In contrast with traditional methods that delete cases with missing data, FIML estimation sorts observations into missing data patterns and each parameter is estimated using all available data for that particular parameter. We used FIML with robust standard errors and included weighting for stratification, clustering, and oversampling to conduct our path analysis. We controlled for sociodemographic characteristics (i.e., gender, age, race-ethnicity, and income) in all models by estimating paths to the mediator (children’s mental health) and the particular outcome as specified by Kenny (2014).

We considered several criteria when evaluating model fit. The test statistic is one measure of overall model fit, however it can lead researchers to reject models with slight departures from data in large samples, as is the case in our study (Bollen & Long, 1993; Jöreskog & Sörbom, 1998). Therefore, we also evaluated three other model fit indices: the root mean square error of approximation (RMSEA) and the comparative fit index (CFI), and the Tucker-Lewis index (TLI). RMSEA values of 0.06 or less along with CFI and TLI values above 0.90 suggest the model is a reasonable fit to the data (Hu & Bentler, 1999).

Detailed Findings

Co-Morbid Physical and Mental Health Care Needs for Children and Youth at Risk for Obesity

Sample characteristics of the full sample of children with BMI, including comparisons to characteristics of CSHCN and non-CSHCN are shown in Table 1. Children identified as having special health care needs tend to have proportionally higher rates of overweight (17% vs. 16%) or obesity (19% vs. 16%) compared to children overall. They are more likely to be boys (57% vs. girls 43%), White, have lower rates of physical activity, and are more likely to have public insurance. Electronic device time use has higher proportions of CSHCN at the extremes (no use and high use). CSHCN are also less likely to live in safe communities. Results of the chi-square tests informed the variable selection for the path model testing mediation by physical activity specifically for children with co-morbid special health care needs.

Tests for multi-group modeling of risk of obesity and overweight showed that physical activity was a significant mediator for gender and age variables (Table 2). Boys and younger children had higher levels of physical activity and physical activity was protective against risk of overweight/obesity, controlling for race/ethnicity, poverty level, maternal health, insurance
coverage and prescribed medications. Electronic device time use and neighborhood safety, which showed associations in chi-square analyses, did not show a significant indirect effect in the path model.

**Childhood Adversity and Risk of Obesity and Diminished Academic Engagement**

The results suggested the model depicted in Figure 1 fit the data well ($\chi^2$ (6, N=65,680)=19.65, p<.003; RMSEA=0.006 [90% CI 0.003, 0.009]; CFI=0.996; TLI=0.9747). Table 4 presents details for the unstandardized path coefficients estimated from this model.

School Engagement. We hypothesized that child’s mental health (i.e., the number of current mental health diagnoses) would mediate the associations between the family adversity score, caregiver mental health, and school engagement. There was a negative direct relationship between school engagement and the number of current mental health diagnoses (. Our results provide evidence of partial mediation, as we found negative indirect relationships between school engagement and family adversity score (and caregiver mental health (as well as negative direct relationships between school engagement and family adversity score (and caregiver mental health (. We also found support for our hypothesis that school engagement would be directly associated with living in an unsafe neighborhood (and time spent engaged in physical (and sedentary activity (and. With the exception of black race, all of the socio-demographic control variables were significantly associated with school engagement.

Body Mass Index. We found positive associations between BMI and family adversity score (and time spent engaged in sedentary activity (and. BMI was negatively associated with time spent engaged in physical activity (and. With the exception of mixed/other race, all of the socio-demographic control variables were significantly associated with BMI.

**Autism and Risk of Obesity: Results and Discussion**

In Table 1 we summarize the demographic characteristics of children by autism and obesity. Approximately 2% of the sample consisted of children with autism. These children were typically male (3.598% vs. 0.730%), Hispanic (2.505%) and White (2.399%), younger in age (2.988% for 10-12 years old vs. 1.955% for 13-16 years old), and publicly insured (2.908% vs. 1.971% private). Children with autism also resided in homes with income levels primarily in the 200-399% FPL (2.825%) and single mother households (2.818%). For children with obesity, a large percentage were male (18.143%) Black (22.804%), younger (10-12 years old 21.035%), and either publicly insured or uninsured (both approximately 22%). The largest percentage of obese children were living in households with incomes within the 0-99% FPL and single mothers (21.720%). A larger percentage of children with ASD were sedentary when compared to those that were active everyday in the past week (4% vs. 2%). Similarly, a larger percentage of children who were obese were sedentary when compared to those who were active everyday
in the past week (20% vs. 14%). For children with ASD, the percentage that did not watching TV or playing video games was similar to those that watched less than one hour, 1-3 hours, and more than 4 hours. However, the percentage of children with obesity that watched TV or played video games for more than 4 hours was almost twice as large as those that did not watch any (22% vs. 11%). For the amount of time spent on using electronic devices, we found a greater percentage of both children with ASD and those with obesity not using any electronic devices (5% and 19%) compared to those that used these devices for more than 4 hours per weekday (2% and 17%). One very interesting area considered is school engagement. For both children with ASD and obesity, a significantly larger number indicated not feeling engaged in their school when compared to those that usually or always felt engaged (5% vs. 1.4% ASD, $p<0.001$); (19% vs. 14%; $p<0.001$).

The prevalence of obesity in children with autism was 24.010% compared to 15.251% of children without autism ($p=.001$). These are similar rates as reported in prior studies (Broder-Fingert et al. 2014; Curtin et al. 2010). Children with autism were more likely to be obese than children without autism; the odds of obesity in children with autism was 1.565 (95% CI, 1.042, 2.320, $p=.032$) compared to children without autism. These logistic regression findings are presented in Table 2. We identified gender, race/ethnicity, age, insurance coverage, and income level, and activity level past week, and four hours or more spent on an average weekday watching TV/playing video games as significant correlates of obesity, and these factors were included in our multivariable logistic regression model. In this model adjusting for the above covariates, the odds of obesity remained higher in autistic children compared to typically developing children. Additionally, we included whether or not the child was taking medication to manage their emotional, concentration, or behavior issues; this was not significantly associated with obesity for children with ASD. Also, school engagement was included but was not a significant correlate of obesity. Tests for moderating effects of demographic variables were not significant and thus not included in the final model.

In this large, nationally representative cross-sectional survey of children in the United States, we observed significantly higher odds of obesity in children diagnosed with autism compared to children without autism. A statistically significant association persisted after adjusting for socio-demographic covariates. While there are a number of potential explanations for the association between autism and obesity in children, a definitive cause is not yet clear. In addition, few studies have examined the directionality of the association. Often, children with autism can be picky eaters or sensitive to certain foods (Linda G. Bandini et al. 2010). They may also have decreased levels of physical activity and prefer sedentary hobbies such as computers or video games (Mazurek et al. 2012). These issues may be worsened by the use of psychotropic medications, which can cause severe weight gain and metabolic problems, particularly in adolescence when there are already hormonal changes that impact growth and weight gain (Maayan and Correll, 2011).

Our results failed to show an association with the broad category of medication use, as available in this dataset. However this variable lacks specific information about medications and usage, and thus our results add to mixed findings on the potential influence of medication.
recent study that found that taking psychotropic medications did not significantly increase rates of obesity for children with ASD (Egan et al. 2013), while prior research found a relationship between medication and obesity for children with ASD (Demb et al. 2011; Martin et al. 2004) and that for younger children and those treated with higher doses, the risk for weight gain is greater (Hoekstra et al. 2010). These mixed findings in the literature may in part reflect variations in the risk of weight gain for different medications or medication categories. Medications such as stimulants which are used to treat inattention and hyperactivity disorders (which can be co-morbid with autism) are not usually associated with weight gain, but weight loss (Durá-Travé et al. 2012). Other medication categories such as the atypical antipsychotics are often prescribed to youth with autism to manage moderate to severe irritability, agitation or aggression (Maloney et al. 2013) and can lead to increased appetite, weight gain (Boon-Yasidhi et al. 2014; Wink et al. 2014), somnolence (Kirino 2014) and metabolic abnormalities that can lead to insulin insensitivity and type 2 diabetes (Caccia 2013).

Lastly, there is data showing that children with ASD have motor impairments that negatively impact their ability to participate in sports or physical activities successfully (Ament et al. 2015; Dowell et al. 2009). These motor impairments combined with deficits in social skills that are necessary for participation in structure activities with peers, makes contribute to lower rates of physical activity (Curtin et al. 2010). While our data does not indicate that school engagement can play a protective factor in obesity prevention or reduction for children with ASD, it does indicate that larger percentages of students with ASD and obesity do not feel engaged in their schools. Our data suggest that physical activity programs that incorporate a video or game component (i.e., a stationary bicycle with a TV or game) may facilitate their participation and amount of time exercising. Moreover, it is clear from our analysis that there is an added risk of obesity for children in lower income and single parent households who may have limited access to healthy food and physical activity options so the presence of exercise equipment that will engage children with ASD on a school campus is crucial to obesity prevention efforts.

**Discussion, Interpretation of Findings, and Conclusions**

**Co-Morbid Physical and Mental Health Care Needs for Children and Youth at Risk for Obesity**

We add to the understanding of the risk and protective factors of obesity in young children by examining these associations for children with compromised health status. Children with co-morbid physical and mental health care needs have higher risk for overweight and obesity status and tend to have lower rates of regular physical activity. These associations have been found in convenience samples and are replicated here with a nationally representative sample. This adds to our understanding of recent trends showing improvements in children’s obesity risk in a number of states and geographic regions (RWJF).

In this national sample of children with comorbid physical and mental health care needs, physical activity was found to be protective against risk of overweight/obesity status. Results support patterns of physical activity levels hypothesized for this study and reflected in the
literature. Boys are reported to be more physically active than girls and older children are less active than younger children.

We found several significant group level differences in the descriptive results that did not carry over into the mediated models. In these cases, potential associations with obesity may be explained through other mechanisms (older children are more likely to spend greater time using electronic devices) or through direct associations. Time spent on electronic devices may lead to sedentary patterns.

Physical activity may include informal outside play, which may be discouraged by parents who report living in unsafe neighborhoods. Additionally, these neighborhoods deemed as unsafe may also lack the resources for organized physical activities such as sports. The recommended activity level for children is 60 minutes per day (CDC Physical Activity Guidelines for Americans). We found that higher physical activity is associated with lower BMI. The measure used in the NSCH inquires about days of physical activity in the past week rather than hours per day. However, even using this approximate comparison reveals that less than a fourth of children appear to meet recommended guidelines.

Results underscore the need for opportunities for physical activity for children with functional limitations.

Policy and Practice:
Inclusive recreation is a concept whereby people with disabilities are given the opportunity to participate in recreational activities alongside their non-disabled peers. This is typically achieved by: (1) making activity modifications (ex. Wheelchair basketball); (2) using assistive technology (standing frames, pool lifts, modified bike, sail, and ski); and (3) design of parks/gyms (Boundless Playgrounds).

Inclusive recreation should be made available widely because:

- Lower levels of exercise can lead to more health care problems and increased weight gain.
- Regular physical activity results in increased in strength, coordination and locomotion. This makes activities of daily living become easier, less help may be needed from others, and quality of life can be improved.
- It is important for children with disabilities to feel a part of all aspects of society and be able to do many activities alongside their peers. They can also learn from their peers in an informal way.
- For children without disabilities, it is an also an informal lesson of respect for all people who all have differences and leads to a greater understanding of different kinds of disabilities and special health care needs.
Childhood Adversity and Risk of Obesity and Diminished Academic Engagement

The findings from this study are important as they highlight the fact that the risk for negative education and health outcomes for children exposed to early adversity and trauma may begin to appear during childhood and adolescence. A constellation of risk exists for poorer children living in unsafe neighborhoods. Poor academic engagement can have lead to school failure, and the health risks of overweight and obesity in children are likely to persist into adulthood, highlighting the urgency for timely intervention. This study clearly demonstrates the need for educators and school-based mental health providers to consider mental health screening with consideration of trauma exposure in determining response to internalizing and externalizing student behaviors, given the high prevalence rate and the negative impact of these experiences that may occur at crucial developmental and educational periods in children’s lives. Similarly, new research on adults’ physical activity and mental health has shown exercise to be effective in treating depression, especially when combined with cognitive control processes in treatment (Alderman, Olson, Brush, & Shors, 2016), yet these relationships are only beginning to be explored for children.

Results suggest the need for improved screening for students who exhibit internalizing and externalizing symptoms, and highlight the potential of physical activity as an effective component of both health promotion and academic engagement. Addressing the impact of trauma exposure should be part of a larger health and wellness paradigm within school settings (Caffo & Belaise, 2005), integrating a holistic concept of students with healthy bodies and minds. The importance of physical activity as a protective factor for mental health (Josefsson, Lindwall, & Archer, 2014, Paluska & Schwenk, 2000), physical health and management of chronic illness (Marrone et al., 2009; Tercyak & Tyc, 2006), and academic performance (CDC, 2011; Efrat, 2011) is emerging as a critical area of study. Numerous school-based interventions have been developed to improve health outcomes, and while outcomes have been promising the understanding of mechanisms requires further study (Demetriou & Höner, 2012; Erwin et al., 2012). As a matter of policy, physical education should remain a regular part of the school day.

Autism and Risk of Obesity

In this large, nationally representative cross-sectional survey of children in the United States, we observed significantly higher odds of obesity in children diagnosed with autism compared to children without autism. A statistically significant association persisted after adjusting for socio-demographic covariates. While there are a number of potential explanations for the association between autism and obesity in children, a definitive cause is not yet clear. In addition, few studies have examined the directionality of the association. Often, children with autism can be picky eaters or sensitive to certain foods (Linda G. Bandini et al. 2010). They may also have decreased levels of physical activity and prefer sedentary hobbies such as computers or video games (Mazurek et al. 2012). These issues may be worsened by the use of psychotropic medications, which can cause severe weight gain and metabolic problems, particularly in adolescence when there are already hormonal changes that impact growth and weight gain.
Our results failed to show an association with the broad category of medication use, as available in this dataset. However this variable lacks specific information about medications and usage, and thus our results add to mixed findings on the potential influence of medication. A recent study that found that taking psychotropic medications did not significantly increase rates of obesity for children with ASD (Egan et al. 2013), while prior research found a relationship between medication and obesity for children with ASD (Demb et al. 2011; Martin et al. 2004) and that for younger children and those treated with higher doses, the risk for weight gain is greater (Hoekstra et al. 2010). These mixed findings in the literature may in part reflect variations in the risk of weight gain for different medications or medication categories. Medications such as stimulants which are used to treat inattention and hyperactivity disorders (which can be co-morbid with autism) are not usually associated with weight gain, but weight loss (Durá-Travé et al. 2012). Other medication categories such as the atypical antipsychotics are often prescribed to youth with autism to manage moderate to severe irritability, agitation or aggression (Maloney et al. 2013) and can lead to increased appetite, weight gain (Boon-Yasidhi et al. 2014; Wink et al. 2014), somnolence (Kirino 2014) and metabolic abnormalities that can lead to insulin insensitivity and type 2 diabetes (Caccia 2013).

Lastly, there is data showing that children with ASD have motor impairments that negatively impact their ability to participate in sports or physical activities successfully (Ament et al. 2015; Dowell et al. 2009). These motor impairments combined with deficits in social skills that are necessary for participation in structure activities with peers, makes contribute to lower rates of physical activity (Curtin et al. 2010). While our data does not indicate that school engagement can play a protective factor in obesity prevention or reduction for children with ASD, it does indicate that larger percentages of students with ASD and obesity do not feel engaged in their schools. Our data suggest that physical activity programs that incorporate a video or game component (i.e., a stationary bicycle with a TV or game) may facilitate their participation and amount of time exercising. Moreover, it is clear from our analysis that there is an added risk of obesity for children in lower income and single parent households who may have limited access to healthy food and physical activity options so the presence of exercise equipment that will engage children with ASD on a school campus is crucial to obesity prevention efforts.

Explanation of study limitations

BMI level is highly influenced by nutritional intake, however, the NSCH dataset lacks critical information on eating behaviors. Some special health needs conditions are associated with eating patterns that may affect obesity risk. For example, children on the autism spectrum have been documented to limit food choices by color, which may lead to over consumption of low nutrient but high calorie carbohydrates. Additional research is necessary to investigate the combined contribution of physical activity and nutrition on BMI for children with special health care needs.
Research on medication use has shown differing associations with BMI. Weight gain is a known side effect for autism (Dove et al. 2012), antipsychotic (Martínez-Ortega, 2013), mood disorder (Goldstein, 2011), and schizophrenia (Kemp et al., 2013) medications for children and adolescents. In contrast, stimulants prescribed for ADHD may be related to loss of appetite and temporary weight loss (Lerner et al. 2008). Information on medication use in the NSCH is general without information about specific prescriptions, thus may obscure potential associations with BMI for this sample.

Children with autism have substantial medical utilization and health-related expenditures (Liptak et al. 2006) that will only increase if obesity-related health complications are added to their condition. More importantly, obesity may dramatically impede their long-term health and quality of life. While there has been a link between eating disturbances and ASD historically recognized, there is a need for further research to have clear estimates of obesity prevalence among children with autism spectrum disorders and to examine the factors associated with obesity in this population. Prevention and intervention approaches for this group of children should take their unique needs into account.

List of products (peer reviewed articles, books, chapters in books, conference presentations, etc.).

Published


Under revision to be resubmitted for peer review


In progress


Conference Presentations


Dissemination activities and plans beyond peer-reviewed publications

August 6, 2014. AMCHP’s State Public Health Autism Resource Center (SPHARC) Grantee’s meeting. Research Brief on Autism and Obesity. Available online: www.communitybasedservices.org. Copies of this brief were distributed to all participants at the grantees meeting.

October 30, 2014. Wellesley College Lunchtime Seminar Series. Co-Morbid Physical and Mental Health Care Needs for Children and Youth at Risk for Obesity. Audio archive available online: www.wcwonline.org/audioarchive. Preliminary analyses were presented to approximately 30 researchers, educators, and clinicians.

Proposals for conference presentations were submitted to AMCHP for their annual conference in January and SRCD national conference. Unfortunately, this presentation was not selected for these conferences.

Describe plans to continue this line or program of research through additional external funding

As of the writing of this report, the PI Michelle Porche is finalizing a transition to Boston University School of Education in the department of Counseling Processes and Applied Human Development. This department includes specializations in Physical Education as well as Health Education. I have begun planning collaboration with key faculty members and with a community organization that uses sport to address mental health issues, in order to further explore child health outcomes of BMI and mental health related to physical activity. We are particularly interested in the how these relationships are affected by experiences of adversity. We are currently reviewing appropriate funding mechanisms to support this work.