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ORIGINAL PAPER

Leisure Participation Patterns for School Age Youth with Autism Spectrum Disorders: Findings from the 2016 National Survey of Children's Health

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Abstract
Leisure activity participation is important for health and well-being. This study examined similarities and differences between typically developing children and those with autism spectrum disorders (ASD) from 6 to 17 years old in *physical, recreational, social, skill*, and *jobs/chores activities* from a large national database. Findings revealed that children with ASD had significantly lower participation levels than those without ASD between 11 and 17 years old. They suggest an increasing disparity among many types of leisure participation for children and youth with ASD as they age, eventually leading to limited participation in adult activities. They reinforce the importance of intervention at an early age to increase participation in these activities to promote development of skills that contribute to adult competencies.

Keywords Autism spectrum disorders · Children · Youth · Physical activity participation · Social participation

Introduction

Participation in recreation and leisure activities is important for physical health, mental health and well-being (Potvin et al. 2013). Leisure is a term that encompasses time that is spent without demands of survival activities, work, or sleep whereas recreation includes activities that individuals engage in during their leisure time for the purposes of pleasure, education, or satisfaction (Ziegler 1965). Across participation studies, the line between leisure and recreation activities is blurry and differentiating activities between the two categories is not consistent. Engagement in these types of leisure activities was significantly correlated with quality of life (QOL) in individuals with ASD in a study by Billstedt et al. (2011), suggesting it as a possible proxy for QOL in ASD. QOL among individuals with autism spectrum disorders (ASD) has been consistently found to be lower than that of typically developing individuals across the age span from childhood to adulthood (Barneveld et al. 2014; Ikeda et al. 2014; Potvin et al. 2015). QOL is a measurement of an individual's perception and participation in their life events and takes into account the concepts of health, well-being, independence, social relationships, beliefs, living conditions, family relations, education, and leisure (Egilson et al. 2017; Billstedt et al. 2011). Therefore, because leisure participation is closely related to QOL and is malleable as a potential target for intervention, this study will compare leisure participation between children and adolescents with ASD and those who are typically developing. It will also examine patterns of change across the ages, comparing these two populations.

Literature Review

Not surprisingly, participation in leisure is lower in children, adolescents, and adults with ASD compared to typically developing peers. Hochhauser and Engel-Yager (2010) found that children with ASD demonstrated less diversity and intensity than the typically developing control group. When looking at specific differences in participation, consistent with the previous study, Hilton et al. (2008) found

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that children 6–12 years old in the high functioning ASD group participated in fewer activities than the typically developing control group. Differences were found in *social activities, physical activities*, and *self-improvement activities* but not in the areas of *skill-based activities* or *recreational activities*. The authors hypothesized that differences were not observed in recreational activities because those activities can be completed alone and in skill-based activities because they would be more structured and organized by the parent.

Potvin et al. (2013), comparing 7–13 year olds with high functioning autism and a peer control group, found that the ASD group participated in fewer *physical activities*, more *pretend play*, and similar intensity of participation in *recreational activity* to their peers. The findings of less participation in physical activities and similar levels of participation in recreational activities was consistent with Hilton et al. (2008).

Solish et al. (2010) looked at participation in *social, recreational*, and *leisure activities* among typically developing children, children with ASD, and children with intellectual disability (ID) between the ages of 5 and 17. Solish et al. (2010) found that children with ASD and children with ID participated in fewer *social* and *recreational activities* compared to typically developing peers but participation was similar in *leisure activities*. The authors hypothesized this was to be expected as the *leisure activities* were home based, solitary, and passive in nature.

In a study comparing the social participation of typically developing children, children with ID, and children with ASD and ID aged 3–19, Taheri et al. (2016) found that the ID and ASD with ID group participated in fewer *social activities* including *unstructured play, social outings, special occasions, sports teams, lessons*, and *community activities*. The ASD with ID group differed from the ID only group in that they participated even less in *social activities* such as having special occasions with friends and decreased recreational activities which were defined as different types of lessons.

In the area of *physical activities*, children with ASD have consistently demonstrated lower levels of participation (Hilton et al. 2008; Memari et al. 2015; Potvin et al. 2013). Must et al. (2014) investigated the specific patterns of participation in *physical activity* in a group of children with ASD compared to typically developing children. In a sample of 111 children (n = 58 typically developing, n = 53 ASD) aged 3–11, the children with ASD demonstrated more time spent in sedentary behavior than typically developing children. Children with ASD watched more television and television time was inversely correlated with physical activity which was a pattern not present in the typically developing peers. The typically developing peers were similar to the ASD group in computer time each day and video game use and the amount of time spent in sedentary behavior on the weekends. Although, typically developing children spent more time doing crafts and playing board games than did the children with ASD on the weekend.

Hilton et al. (2008) and Potvin et al. (2013) define *self-improvement activities* to include reading, writing letters, getting help from a tutor, doing chores, religious activity, and volunteer work. In a study comparing adolescents with ASD to typically developing group, the ASD group was less likely to participate in community service (Lee et al. 2008). Reynolds et al. (2011) found that children with ASD are required to do fewer chores that their typically developing peers and children with ASD participated in fewer activities that required the care of others including babysitting, caring for a pet, and general cleaning. These studies are consistent with Hilton et al. (2008) that children with ASD differ in their participation of *self-improvement activities*.

Developmental Trajectory

Participation has been consistently lower across the lifespan for individuals with ASD. Studies have cited differences in participation in preschoolers (LaVesser and Berg 2011), children (Brewster and Coleyshaw 2010; Hilton et al. 2008; Little et al. 2014; Must et al. 2014; Reynolds et al. 2011; Solish et al. 2010), adolescents (Bohnert et al. 2016; Orsmond et al. 2004; Taheri et al. 2016), and adults (Badia et al. 2013; Billstedt et al. 2011; Orsmond et al. 2004) but the specific developmental trajectory of participation across childhood has yet to be evaluated in studies of participation for individuals with ASD. The developmental trajectory of participation has clinical implications for development of treatment interventions for children with ASD.

Leisure Participation Categories

The construct of leisure participation and the categories of activities that are encompassed in the different subtypes of leisure are poorly defined in the ASD literature. Studies often categorize activities into types of participation based on the assessments performed (Hilton et al. 2008; Little et al. 2014; Potvin et al. 2013; Solish et al. 2010) so that the participation literature has similar activities identified under different subtypes of recreation and leisure. The following is a discussion of different assessments used in the literature to measure leisure participation and the categories of activities that was used to identify variables used in this study.

The Children's Assessment of Participation and Enjoyment/Preference for Activities of Children (CAPE/PAC: King et al. 2004) is an assessment used to measure children's participation in everyday activities outside of their mandated school and self-care activities, based on the World Health Organization's International Classification of Functioning

(ICF) (Potvin et al. 2013). The CAPE/PAC breaks down participation into the categories of *recreational, physical, social, skill-based*, and *self-improvement* (King et al. 2004). Solish et al. (2010) created an Activities Questionnaire for the study that separated activities into the categories of *social, recreational*, and *leisure activities*. Little et al. (2014) used the Home and Community Activity Scale (HCAS; Dunst et al. 2000), which categorizes activities into *parent–child household activities, community activities, routine errands, neighborhood-social activities, outdoor activities*, and *faith-based activities*. The Leisure Activity Inventory characterizes participation activities into categories of *social activities, activities at home*, and *physical activities* (Badia et al. 2013). The Participation and Environment Measure for Children and Youth (PEM-CY) is a parent report that categorizes participation within the home, school, and community (Egilson et al. 2017).

Orsmond et al. (2004) used a modified version of the National Survey of Families and Households (Bumpass and Sweet 1987) to measure participation in social and recreation activities among adolescents. Nine activities were used as measures of participation in social and recreation activities and included: *socializing with school or work friends, socializing with friends or neighbors, socializing with relatives, participating in group recreational activities, attending religious services, attending social events at religious settings, working on a hobby, taking a walk or other exercise*, and *taking a trip or traveling*. Similarly, *out-of-school time* (OST) was measured by combining seven measures of OST participation which included: *community programs, athletics, scouting, lessons, school activities*, and *service clubs*.

Other studies asked parents about the activities in which their child participated, coded them, and created categories of participation. Reynolds et al. (2011) used the Competence Scale of the Child Behavior Checklist (Achenbach and Rescorla 2001), which asked to parents to write in their child's participation in the areas of *activities, social*, and *school performance*. The responses were coded into hobbies and activities category, and jobs and chores category. Bohnert et al. (2016) coded parents' responses of organized activity participation into five categories which included: *religious, academic, performance/fine arts, sports*, and *community service*.

Depending on the focus and theoretical constructs of the assessments, categories have often been defined based on the environment where the activity occurs (i.e. home or community), based on the type of activity (scouting, recreation, etc.), or the underlying performance components required to complete the activity (physical, social, etc.). Specific assessment items or participation activities are then placed in the categories of the assessment based on its related theoretical constructs of participation. The literature demonstrates inconsistent delineation of activities into categories of participation as researchers' approach, understanding participation from differing theoretical foundations, and varying research aims. Consistency across studies is beneficial to promote the understanding of participation patterns for children and youth with ASD. We attempted to identify consistencies in labeling activities and generated Online Appendix 1 from those, which we used to develop the categories for this study (see Online Appendix 2).

Physical Activities

Patterns across studies have consistently found that children with ASD demonstrate difficulties in activities with physical demands. Activities with physical demand requirements are categorized as *physical activities* by Hilton et al. (2008) and Potvin et al. (2013), but included in the *recreational* category by Solish et al. (2010). Frequency of participation in all of these were found to be consistently lower in children with ASD. Studies generally agree that *physical activities* include participation in sports, sports lessons, playing on a team, bicycling, individual physical activity, martial arts, and track and field. For this study, *physical activities* include exercise, playing a sport, or participating in a physical activity for at least 60 min (see Online Appendix 2).

Recreational Activities

Recreational activities described in the literature encompass a broad range of activities (see Online Appendix 1). Reynolds et al. (2011) identified activities as leisure for those solitary activities requiring little social skills and little functional independence. *Recreational activities* for this study encompass activities that provide pleasure, education, or satisfaction and can require limited social engagement, physical effort or functional independence by the participator. They include watching television and videos, playing video games, using computers, cell phones, and other electronic devices (see Online Appendix 2).

Social Activities

Social activities involve the engagement of individuals with others in social interactions to satisfy needs or ensure survival (Levasseur et al. 2010). These criteria were used to categorize social activities for this study (see Online Appendix 2). They include participation in clubs or organizations outside of school and eating meals together with the family.

Skill Activities

Skill activities involve utilizing or developing a skill. In several studies, they involve lessons or activities that require special abilities to engage in them. Solish et al. (2010) and Taheri et al. (2016) included art and music lessons in the *recreational* category, while Hilton et al. (2008) and Potvin et al. (2013) categorized these activities as *skill based activities*, and also included community organizations, singing, swimming, horseback riding, and gymnastics. The activities most consistent across studies that will be included in this category for the present study include lessons, such as music, dance, language or other arts and participation in sports teams or lessons (see Online Appendix 2). We included participation in sports teams as a skilled activity in this study because of the literature indicating that participation is inhibited in youth with ASD because they lack the motor skills and social skills to participate and enjoy participating (Memari et al. 2015; Stanish et al. 2015). We thought that participation in community organizations more appropriately fit in *social activities*, so included it there.

Jobs/Chores

Jobs and chores entail tasks that require work by the individual. Included are tasks that may or may not result in pay, are required but may not be perceived as fun, and result in the caring for something or someone else. Little et al. (2014) and Reynolds et al. (2011) included aspects of jobs and chores when evaluating participation in children with ASD. Completing jobs/chores has long-term implications for functioning as an adult (Reynolds et al. 2011). For this study, *jobs and chores* includes working for pay, including regular jobs as well as babysitting, cutting grass, or other occasional work and participating in any type of community service or volunteer work at school, church, or in the community (see Online Appendix 2).

Study Aims

Studies have compared the developmental trajectory of participation in leisure activities across a wide range of ages from early childhood to adolescence between children with and without ASD. However, no single study has examined the entire age range to determine how participation differs from elementary school through high school. This study aims to (1) determine the similarities and differences between typically developing children and those with ASD from 6 to 17 years old and (2) determine the areas that are most different between typically developing children and those with ASD in the described areas of *physical, recreational, social, skill*, and *jobs/chores activities* from a large national database. We hypothesized that areas of difference would include lower levels of *physical activity* participation (Must et al. 2014), *skill* and *job/chore* participation and similar participation in *recreational activities*, specifically sedentary use of electronics. Additionally, we expected the gap to become larger for the older children based on previously published research of decreased participation as youth approach young adulthood (Hilton et al. 2008; McCollum et al. 2016; Wang and Berg 2014). Understanding the participation patterns of children with ASD and where there are major gaps on the developmental trajectory has clinical implications for treatment of children with ASD and long term QOL.

Methods

Participants

The National Survey of Children's Health (NSCH) is a large cross-sectional data set that includes responses of parents and caregivers of children to questions that ask about children's health and well-being, including the level of participation in various types of activities (CAHMI 2018). The NSCH is representative of the United States (US) population of non-institutionalized children ages 0–17 in all 50 states (a total of 50,212 NSCH interviews) based on address-based sampling (ABS) frames which is conducted by the Census Bureau of the US from June 2016 through February 2017. Households were contacted by random mailings to identify those with one or more children under 18 years old. One child in each household was randomly selected to be the subject of the survey. Approximately 985 in each state and the District of Columbia responded, ranging from 638 in Mississippi to 1,351 in Minnesota. Survey results were adjusted and weighted to reflect the demographic composition of non-institutionalized children and youth from age 0–17 in each state. The study data set is available from the Data Resource Center for Child and Adolescent Health (DRC) website at http://www.childhealthdata.org.

In our study, the inclusion criteria consist of children who (1) are between 6 and 17 years old and (2) do not have ID, which was defined as having a doctor, other health care provider, or educator who told the parent that the child has ID or mental retardation. Exclusion of ID was to eliminate the confounding impact of intelligence level on participation. This study was approved by the Institutional Review Board of the University of Texas Medical Branch as exempt from a full board review due to the de-identified public use data and complies with the NSCH Data Use Agreement.

Children with ASD were defined by two survey questions, "*Has a doctor or other health care provider EVER told you that this child has Autism or Autism Spectrum Disorder (ASD)? Include diagnoses of Asperger's Disorder*

or Pervasive Developmental Disorder (PDD)—K2Q35A" as well as "*Does this child CURRENTLY have the condition?*—K2Q35B." If the parents or caregivers of the child answered "*yes*" to both questions, the child was assigned as having ASD otherwise he/she was assigned as not having ASD (unaffected or controls). We divided the age range of 6–17 years old into five categories based on the age distribution of the study cohort and eligibility of driving, including ages 6–8, 9–11, 12–13, 14–15, and 16–17.

Participation Categories

Activity participation categories include *physical activities, recreational activities, social activities, skill activities*, and *jobs/chores* (Online Appendix 2). Except for the *physical activities* (1 = 0 days to 4 = everyday) and *recreational activities* (0 = do not watch TV/use electric devices to 4 = watch TV/use electric device 4 h or more per day), categories have a 4-point rating scale, the rating scale of the variables in the three other categories were collapsed into a dichotomous rating scale (1 = no, 2 = yes). We modified and reversed the ratings scales of the *social activities, skill activities* and *jobs/chores* categories to reflect that a high score indicates a high level of participation (1 = yes, 0 = no). For the statistical analysis, we used the sum of raw scores in each category which resulted in a score range of 1–4 for *physical activities*, 0–6 for *recreational activities,* and 0–2 for *social activities, skill activities* and *jobs/chores* category.

Covariates

The participation covariates include sex (boy, girl), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), having attention deficit disorder (ADD) or attention deficit/hyperactivity disorder (ADHD) (yes, no), current health insurance (yes, no), living in working poor families defined by incomes less than 100% of the federal poverty level (yes, no), highest level of educational attainment of adult in household (1 = less than high school to 4 = college degree or higher), overall health status of mother (excellent/very good, not), overall health status of father (excellent/very good, not), supportive neighborhood (yes, no), and safe neighborhood (1 = definitely agree to 4 = definitely disagree).

Statistical Analysis

We conducted descriptive statistics, including independent *t*-tests or Wilcoxon rank-sum test depending on the continuous variables' normality distributions and Chi square tests for categorical variables to determine demographic differences between children with ASD and those without ASD. We investigated the participation differences between children with ASD and those without ASD within the five age groups (6–8, 9–11, 12–13, 14–15, and 16–17 years). We used multivariate regression models for the sum scores of the five participation categories to examine the differences between groups and across the five age groups within each diagnostic group by accounting for the participation covariates, including gender, race/ethnicity, having ADHD, current health insurance, living in working poor families, education attainment of adult in household, overall health status of mother and father, supportive neighborhood, and safe neighborhood.

We weighted all analyses using the survey sampling weight to reflect the US population estimations. We utilized the domain analysis to estimate the adjusted means of participation levels within the five participation groups and across five age groups within each diagnostic group (Turyk et al. 2007). Statistical significance was determined at an alpha level of .05 with two-tailed tests and the study results were expressed with 95% confidence intervals (CIs). All analyses were conducted with the SAS statistical software (Version 9.5; SAS Institute, Cary, NC) for complex study designs.

Results

Among the total sample of 50,212 in the 2016 NSCH, we excluded subjects under 6 years old ($n = 14{,}494$) and with ID ($n = 438$), which resulted in a sample size of 35,280. In the final sample, the number of children with ASD was 823 (2.33%) and the prevalence rate of ASD ages 6–17 years old in the US population was estimated as 2.14% ($n = 1{,}051{,}666$ children). Boys had a high ASD prevalence rate compared to girls (1.79%, $n = 880{,}938$; 0.34%, $n = 170{,}728$, respectively). Table 1 presents demographic characteristics between children with ASD and those without ASD. Children with ASD had higher numbers of boys, having ADHD, living in working poor families, having poor health status of mother and father, having a non-supportive neighborhood, and not having a safe neighborhood.

Table 2 and Fig. 1 present the adjusted means of the five participation categories between children with ASD (black bars) and those without ASD (gray bars) within the five age groups (6–8, 9–10, 11–12, 13–15, 16–17 years old). Across age groups, the standard errors for the control group were much smaller than that of the ASD group, which resulted in more significant differences across age groups for those with ASD (see Online Appendix 3).

Physical Activities

Children with ASD demonstrated lower participation levels compared to unaffected children for all age groups. Between ages 11 and 17 years, the differences were significant (panel

Table 1 Demographics between children with ASD and those who without ASD

Characteristics	Total (N = 35,280)	ASD (N = 823)	Control (N = 34,457)	*p*
Age, mean (SD)	12.1 (3.4)	12.0 (3.3)	12.1 (3.4)	.9400
Age group				
6–8 years	6981 (19.8%)	163 (19.8%)	6818 (19.8%)	.1796
9–10 years	5155 (14.6%)	111 (13.5%)	5044 (24.6%)	
11–12 years	5602 (15.9%)	148 (18.0%)	5454 (15.8%)	
13–15 years	9743 (27.6%)	240 (29.2%)	9503 (27.6%)	
16–17 years	7799 (22.1%)	161 (19.5%)	7638 (22.1%)	
Gender				
Boy	17,952 (50.9%)	675 (82.0%)	17,277 (50.1%)	< .0001*
Girl	17,328 (49.1%)	148 (18.0%)	17,180 (49.9%)	
Race				
Non-Hispanic White	24,861 (70.5%)	586 (71.2%)	24275 (70.4%)	.6816
Non-Hispanic Black	2101 (6.0%)	54 (6.5%)	2047 (6.0%)	
Hispanic	3891 (11.0%)	82 (10%)	3809 (11.0%)	
Other	4427 (12.5%)	101 (12.3%)	4326 (15.6%)	
ADHD (yes)	4399 (12.6%)	438 (53.3%)	3961 (11.6%)	< .0001*
Current insurance (yes)	33,809 (96.2%)	804 (97.8%)	33,005 (96.2%)	.0145*
Living in working poor families (yes)	2151 (6.2%)	53 (6.5%)	209 (6.2%)	.7192
Parents' education attainment				
Less than high school	824 (2.4%)	20 (2.5%)	804 (2.4%)	.1008
High school degree	4559 (13.2%)	113 (14.0%)	4446 (13.2%)	
Some college	8008 (23.3%)	312 (24.5%)	7795 (23.2%)	
College degree or higher	21,016 (61.1%)	459 (57.0%)	20,557 (61.2%)	
Overall health status of mother (very good)	20,823 (65.9%)	357 (48.3%)	20,466 (66.3%)	< .0001*
Overall health status of father (very good)	18,954 (67.8%)	345 (55.6%)	18,609 (68.1%)	< .0001*
Supportive neighborhood (yes)	21,229 (62.2%)	378 (47.4%)	20,851 (62.5%)	< .0001*
Safe neighborhood, mean (SD)[a]	1.32 (0.55)	1.44 (0.65)	1.32 (0.55)	< .0001*

ASD autism spectrum disorder, *ADHD* attention deficit disorder or attention deficit

*Statistical significant at an alpha level of 0.05

[a]1 = definitely agree, 2 = somewhat agree, 3 = somewhat disagree, 4 = definitely disagree

a in Fig. 1). The levels of participation in both groups were higher in the 6–10 year old categories than in the 11–17 year old categories.

Recreational Activities

There were no differences between the two comparison groups within all five age groups in the *recreational activities* category (panel b in Fig. 1). The older age groups were slightly higher than the younger groups for both the children with ASD and the unaffected children.

Social Activities

For the *social activities* category, participation levels were very close except for age 16–17 years, in which the unaffected group had significantly higher participation than the ASD group (panel c in Fig. 1). The levels of participation were generally stable between ages 6 and 15 years, but were lower for age 16–17 years. For this category, we combined the two variables of *eat a meal together with family members* and *clubs/organization participation after school or weekends* and estimated the level of participation in the two variable by controlling participation covariates (Fig. 2). Upon examining these activities separately, we found very little differences between the two comparison groups in the *eat a meal together with family members* variable (left panel a in Fig. 2), but the children with ASD had a significantly lower participation in the 16–17 year age group compared to the control group in the *clubs/organization participation after school or weekends* variable (right panel b in Fig. 2).

Table 2 Comparisons of adjusted means of the ASD and control group within each age group, mean (standard error)

Age group (years)	Physical Activities			Recreational Activities			Social activities		
	ASD	Control	*p*	ASD	Control	*p*	ASD	Control	*p*
6–8	2.36 (0.23)	2.70 (0.16)	.0838	3.26 (0.31)	3.13 (0.16)	.6427	1.09 (0.10)	1.23 (0.04)	.1321
9–10	2.73 (0.21)	2.98 (0.13)	.1371	3.63 (0.20)	3.55 (0.14)	.5814	1.27 (0.11)	1.34 (0.07)	.4273
11–12	2.06 (0.15)	2.45 (0.12)	.0005*	3.98 (0.20)	3.72 (0.17)	.0668	1.19 (0.13)	1.31 (0.08)	.2921
13–15	2.03 (0.17)	2.41 (0.09)	.0050*	3.62 (0.26)	3.96 (0.15)	.1290	1.30 (0.10)	1.29 (0.05)	.8288
16–17	1.82 (0.16)	2.56 (0.12)	< .0001*	4.23 (0.20)	4.18 (0.11)	.7797	0.78 (0.11)	1.23 (0.08)	< .0001*

Age group (years)	Skill activities			Jobs/chores		
	ASD	Control	*p*	ASD	Control	*p*
6–8	0.48 (0.15)	0.52 (0.08)	.7703	0.21 (0.08)	0.32 (0.06)	.0890
9–10	0.65 (0.20)	0.85 (0.12)	.2192	0.22 (0.14)	0.20 (0.05)	.8886
11–12	0.56 (0.18)	0.93 (0.11)	.0091*	0.13 (0.10)	0.44 (0.07)	.0001*
13–15	0.60 (0.12)	0.95 (0.08)	< .0001*	0.57 (0.13)	0.82 (0.09)	.0115*
16–17	0.35 (0.13)	0.70 (0.09)	.0006*	0.73 (0.13)	1.10 (0.07)	.0017*

Means of the two comparison groups within each age group which accounting for gender, race/ethnicity, having ADHD, current health insurance, living in working poor families, education attainment of adult in household, overall health status of mother and father, supportive neighborhood, and safe neighborhood. High scores reflects a high level of participation

*Indicates statistically significant at an alpha level of 0.05

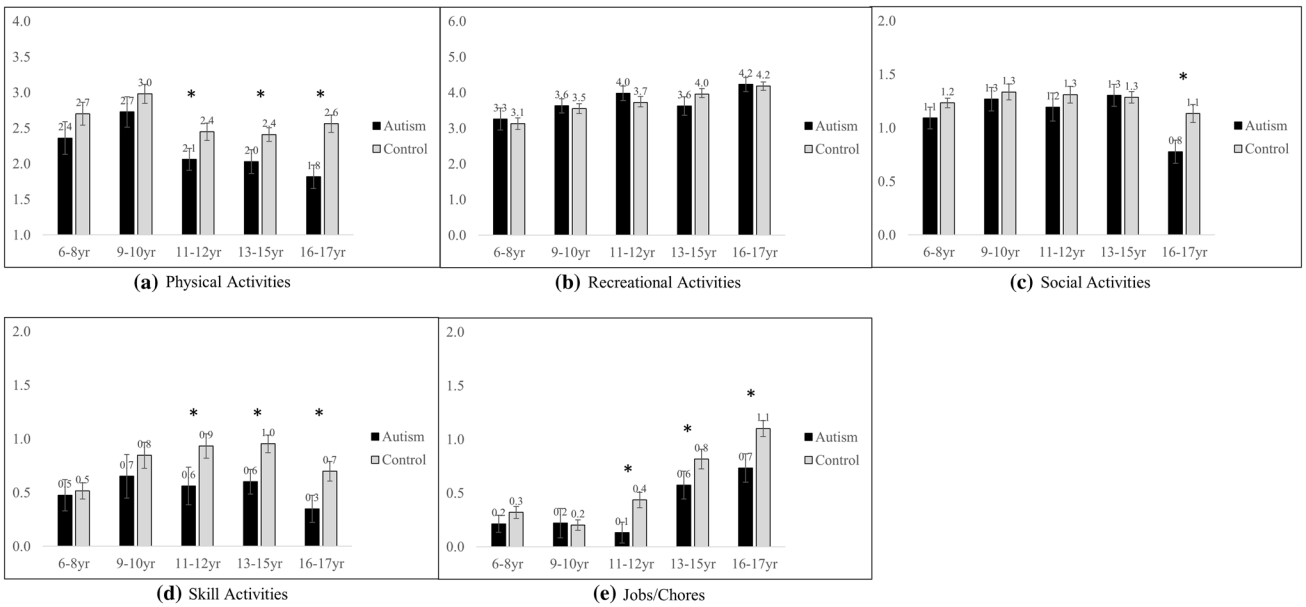
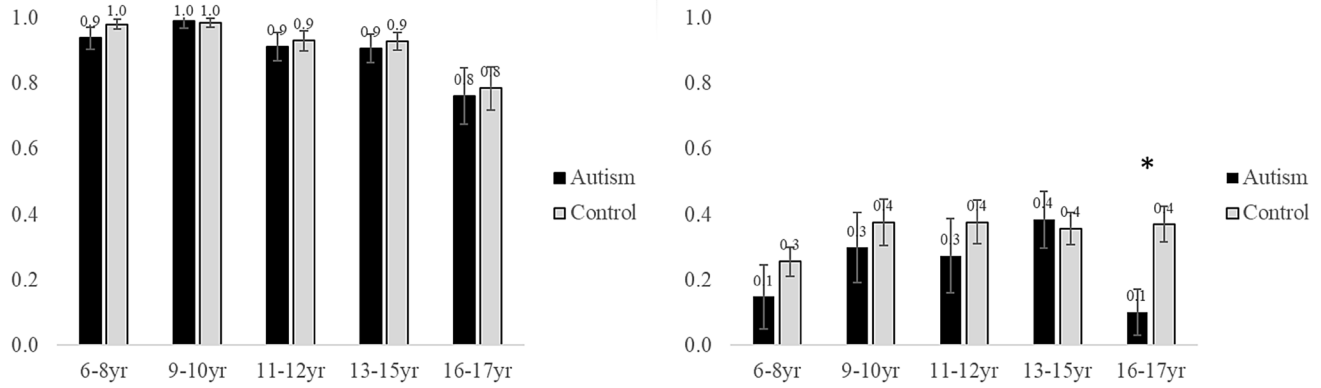


Fig. 1 Comparison of participation categories (**a** *physical activities*, **b** *recreational activities*, **c** *social activities*, **d** *skill activities*, and **e** *jobs/chores*) between children with ASD (black bars) and those who without ASD (gray bars) within age groups (6–8, 9–10, 11–12, 13–15, 16–17 years old). The bar graphs indicate means of each age groups between the two comparison groups which accounting for gender, race/ethnicity, having ADHD, current health insurance, living in working poor families, education attainment of adult in household, overall health status of mother and father, supportive neighborhood, and safe neighborhood. High scores reflect a high level of participation. Asterisk indicates statistically significant at an alpha level of 0.05

Skill Activities

Children with ASD demonstrated lower participation levels compared to unaffected children for all age groups. Between ages 11 and 17 years, the differences were significant (panel d in Fig. 1). The levels of participation tended to increase for the unaffected group from age 6–15, and were lower for age 16–17 years. For the children with ASD, the participation levels were fairly stable until age 15, but decreased for age 16–17 years.



(a) Social Activities – Eat a Meal Together/Family

(b) Social Activities – Clubs/Organization after School

Fig. 2 Comparison of the two *social activities* variables (left—*eat a meal together with family members*, right—*clubs or organization after school or weekends*) between children with ASD (black bars) and those who without ASD (gray bars) within age groups (6–8, 9–10, 11–12, 13–15, 16–17 years old). The bar graphs indicate means of each age groups between the two comparison groups which accounting for gender, race/ethnicity, having ADHD, current health insurance, living in working poor families, education attainment of adult in household, overall health status of mother and father, supportive neighborhood, and safe neighborhood. High scores reflects a high level of participation. Asterisk indicates statistically significant at an alpha level of 0.05

Jobs/Chores

Children with ASD generally demonstrated similar participation levels for *jobs/chores* from age 6 to 10, but significantly lower levels for age 11–17 (panel e in Fig. 1). The unaffected children demonstrated low levels of participation for age 6–10, but increased from age 11–17 years.

Discussion

Overall, children with ASD had low levels of participation in age 11–17 years compared to children without ASD. To the best of our knowledge, this is the first study to investigate the differences in participation between children with ASD and controls across the age range from elementary to high school in a large data set. We weighted all analyses using the study sampling weight to reflect the US population estimations of the age groups. We also controlled for the various personal and environmental covariates related to participation, including gender, race/ethnicity, having ADD or ADHD, current health insurance, living in working poor families, highest educational attainment of an adult in the household, overall health status of the mother and father, having a supportive neighborhood, and having a safe neighborhood. Interestingly, the findings reflected small standard errors across age groups for the controls indicating similarity of scores for each age group (Online Appendix 3). In contrast, the children with ASD had larger standard errors for each age group, indicating greater variation in the participation levels among children with ASD.

Physical Activities

Lower *physical activity* participation levels in children with ASD are consistent with previous studies (Ayvazoglu et al. 2015; Must et al. 2014; Obrusnikova and Cavalier 2011). The lack of significance in the differences for age 6–10 years is inconsistent with most previous study results, with the exception of Badia et al. (2013) study that found that the children with ASD did not demonstrate a statistically significant difference between the amount of time they spent in moderate physical activity compared to the typical control group. Badia et al. (2013) hypothesized that children with ASD, although participating in fewer activities after school, spent more time in pacing, roaming, or self-stimulating behaviors, which would be considered as *physical activities*. A similar phenomenon could be occurring within this sample. This finding may also be explained by the potential for sampling bias having been removed by using the survey sampling weight that reflects the US population estimations. Using data from only one activity item compared to multiple items examined in previous studies may also affect the outcomes.

Lower participation by both groups for children and adolescents in the older groups between ages 11 and 17 may be a result of reduced parent-directed activities for the older children. Larger differences, which were significant, between the children and adolescents with and without ASD between ages 11 and 17 suggest a possible sedentary trend overall, but a stronger trend among individuals with ASD. This trend is reported in other studies (Corder et al. 2016; Bassett et al. 2014) and is concerning because of its potential to impact fitness and overall health in ages closer to adulthood. It

suggests the importance of structured programs to increase engagement in *physical activities* for adolescents with ASD and a focus on addressing motor skills in intervention that could target structured sports activities.

Recreational Activities

Findings indicated no significant differences between the two comparison groups within all five age groups in the *recreational activities* category and that participation by the older ages were slightly higher than for the younger ages for both groups. This may be partially explained by previous findings that watching television and videos, playing video games, using computers, cell phones, and other electronic devices are among the most participated in and most enjoyed activities for both children with and without ASD (Eversole et al. 2016), suggesting that participation by both groups would be similarly high. It is possible, however, that, even though the participation levels are very close, the patterns of participation may be different in a way that the questions in this survey did not capture. For example, the youth with ASD may be participating in more solitary video games, computer use and cell phone use, while the unaffected group may be doing more social media and texting (Mazurek and Wenstrup 2013).

Social Activities

For the *social activities* category, the general stability in the levels of participation except for lower levels among age 16–17 year-olds may be a result of the differences between the two variables. We found no significant differences between the two comparison groups in the *eat a meal together with family members* variable. The participation levels for the age 16–17 years in both groups were lower than that for younger ages. Participation in *clubs/organizations after school or weekends* variable showed a general pattern of increase across the ages for both groups that were generally consistent until age 16–17 years, when the ASD group showed a large drop, while the control group did not. This may be a result of less parental control in this older group with more resistance to participating in the clubs and organizations by the ASD group because of feeling awkward or not being invited to attend. At this age, young adults with ASD are less apt to receive phone calls or invitations to *social activities* (Orsmond et al. 2013), which makes them less interested in participating in them.

Skill Activities

Lack of significant differences in participation in *skill activities* for age 6–10 years between the two comparison groups is not consistent with previous studies. This difference could be explained by the different categorization of skilled activities used in the present study (see Online Appendices 1 and 2). Similar to *physical activities* participation, using the survey sampling weighting and having data from only the two variables (*organized activities or lessons* and *sports teams or lessons*) compared to multiple activities examined in previous studies may also offer some explanation for the differences. Significantly lower participation for the 11–17 year-olds with ASD may be explained by less parental control for these ages and by less interest in participation because of lower skill levels. This suggests the importance of early intervention to support development of skill development in children with ASD.

Jobs/Chores

The significantly lower participation in *jobs/chores* from age 11–17 years among children and youth with ASD is a predictor of the reduced employment among adults with ASD (Roux et al. 2013). These findings may reflect the culmination of the social and motor impairment experienced by the children with ASD and indicates the importance of early intervention to address these issues. Intervention addressing IADLs and incorporating strategies to generalize performance of IADLs are important precursors for jobs and chores.

This large data set provides information more representative of the population of individuals with ASD than smaller studies, but has several limitations. The ASD diagnoses were made by health care providers, but diagnoses were not confirmed by autism assessments. Only a limited number of participation items were included in this analysis because secondary data were used for the analysis. In addition, data are based on parent report, which has the potential for bias.

Conclusions

The study findings from the 2016 NSCH revealed that children with ASD had significantly lower participation levels than those without ASD between 11 and 17 years old. For *physical, recreational, skill* and *jobs/chores* activities, controls were generally higher than children with ASD, with significant differences beginning at age 11. *Recreational activities* were similar between the two groups and *social activities* were similar until age 15, after which controls were higher. These findings suggest an increase in disparity among many types of leisure participation for children and youth with ASD as they age, which contributes to limited participation in adult activities, such as employment, living

independently, and attending college. The findings reinforce the importance of intervention at an early age to increase participation in *physical, social, skill-based, and jobs/chores activities* to promote development of skills that contribute to adult competencies.

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Author Contributions All authors provided concept/idea/research design and writing. KR and CL provided data collection and conducted literature review. IH provided data analysis.

Compliance with Ethical Standards

Conflict of interest Karen Ratcliff declares that she has no conflict of interest. Ickpyo Hong declares that he has no conflict of interest. Claudia Hilton declares that she has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Institutional Review Board of the University of Texas Medical Branch as exempt from a full board review due to the de-identified public use data and complies with the NSCH Data Use Agreement.

Informed Consent It was not possible to obtain informed consent form the participants in this study because the data set is de-indentified and does not contain personal identifying information.

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