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EXAMINING THE RELATIONSHIP BETWEEN SPORTS ACTIVITIES, NUTRITIONAL STATUS AND SLEEP HABITS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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Abstract This study aimed to assess the influence of sports activities on certain nutritional habits, eating issues, food consumption frequencies, and sleep patterns in children with autism, categorized by age groups. This study was cross-sectional and included 93 children between the ages of 3 and 18 years, divided according to participation in sports activities three days a week within autism sports clubs and associations. The investigation employed various tools, including nutrition habit inquiries, a food consumption frequency questionnaire, and the Children's Sleep Habits Questionnaire (CSHQ) Short Form. The findings revealed that children engaged in sports exhibited a higher consumption rate of egg compared to their non-participant counterparts. Moreover, when examining the sleep patterns of children with autism across different ages, it was observed that non-participating children aged 3–5 years had significantly higher CSHQ scores than their sporting counterparts aged 3–5 ($p < 0.05$; $d = 1.71$). This study suggests that involvement in sports activities may serve as a promising strategy for regulating the nutritional intake and sleep patterns of children with autism, thereby potentially enhancing overall sleep quality.

Key words: autism spectrum disorder, CSHQ, eating behaviours, sleep problems

Introduction

Autism Spectrum Disorder (ASD) is a developmental disorder characterized by symptoms such as social-emotional challenges, difficulties in non-verbal communication, repetitive behaviors, restricted interests, sensory sensitivities, and rigid adherence to routines (American Psychiatric Association, 2013). According to the Centers for Disease Control and Prevention (CDC), the prevalence rate of children with autism is 1 in 36. Data from North America, Europe and Asia indicate that the average prevalence is around 1–2% (Centre for Disease Control and Prevention, 2018). Additionally, the prevalence ratio of autism between males and females is reported to be approximately 5:1 (Werling & Geschwind, 2013).

Autism diagnosed children frequently show unhealthy eating behaviours as compared to their peers who are normally developing (Marí-Bauset et al., 2014). Among these behaviors, there is often food selectivity, with a tendency to consume high-energy-dense foods more while consuming fewer fruits and vegetables compared to their typically developing peers (Sharp et al., 2013). These behaviors can persist into adolescence or adulthood. It can lead to an increase in unhealthy body weight and associated health outcomes as a result of imbalanced nutritional intake (Dhaliwal et al., 2019). It has been shown that highly selective eating habits are not necessarily associated with appetite loss in autism diagnosed children, and many parents have reported that their children demonstrate a healthy appetite for foods they enjoy (Cermak et al., 2010). These foods often contain highly processed foods (Hubbard et al., 2014). The consumption of nutrient-poor, energy-dense foods and beverages compared to healthier options may contribute to excessive weight gain in autism diagnosed children.

Autism diagnosed children have a fourfold higher risk of obesity (Broder-Fingert et al., 2014). Children with autism are more than three times more likely to develop metabolic syndrome than neurotypically developing children (Messiah et al., 2015). Children with autism and their families often face various challenges associated with the physical inactivity caused by autism (Healy et al., 2019). Research indicates that individuals with ASD, in addition to the core symptoms of ASD, are at risk of experiencing various issues, including medical and psychiatric conditions (Healy et al., 2018), excessive body weight or obesity (Curtin et al., 2014), sleep disorders (Calhoun et al., 2020), physical inactivity (Liang et al., 2020), motor abnormalities and disorders (Chu et al., 2020) and executive function disorders (Sachse et al., 2013). Exercise is one of the promising compensatory methods that can positively affect cognitive functions from early childhood (Carson et al., 2016) to adulthood (Prakash et al., 2015) and can be used to reduce the risk of age-related cognitive impairment (Erickson et al., 2019) is increasingly emerging (Hirata et al., 2016; Richdale & Schreck, 2009).

There are many internal factors that can influence children's sleep (Borbély et al., 2016). Among the internal factors are age, gender, existing illnesses such as a developmental disorder, obstructive sleep apnea, or the sleep disorder itself, and habits like complementary sleep and exercise. More than 80% of children with neurodevelopmental disorders experience sleep disturbances. Specifically, children with autism spectrum disorder may encounter difficulties not only in staying asleep but also in falling asleep (Blackmer & Feinstein, 2016; Kotagal & Broomall, 2012; Souders et al., 2009).

In the literature, there are studies comparing exercise interventions in children and adolescents with ASD to typically developing children, and there are also studies focusing solely on the impact of exercise on sleep quality (Hirata et al., 2016) or dietary habits (Mendive Dubourdieu & Guerendiain, 2022; Shaly & Sreesna, 2013) in individuals with ASD. To the best of our knowledge, there is no research identified that specifically examines the sleep and dietary habits of children with ASD based on their engagement in sports and categorization into age

groups. Therefore, the aim of this study is to examine the impact of sports activities on the dietary and sleep habits of children with ASD by comparing them across different age groups.

Material and Methods

Participants and Study Design

The study utilized a cross-sectional research design, where participants were contacted and the questionnaire was administered only once. Our study group was formed by categorizing 93 children aged 3–18 years, who are members of autism sports clubs and autism associations. The age-based categorization in our study was carefully selected based on developmental psychology and pediatric literature, which indicate that children with autism spectrum disorder (ASD) exhibit significant changes in behavioral, cognitive, and physiological patterns as they grow. Participants who exercised for at least 150 min/week (engage in sports three times a week) were included in the "sports" group, while those performing <150 min/week were included in the "non-sports" group. To be included, participants had to be between the ages of 3 and 18 years old, diagnosed with ASD, and have a parental consent form.

The exclusion criteria for the study included children with diagnoses other than Autism Spectrum Disorder, individuals over the age of 18 years, and children who incompletely filled out the data collection tools. A total of 121 individuals were reached; however, 14 children were excluded due to having a diagnosis other than autism, 13 children were excluded because they were over 18 years old, and 1 child was excluded due to incomplete filling out of the data collection tools. The ethical principles of the Helsinki Declaration were taken into consideration in the study. Before commencing the study, an informed consent form was shared with families and educators. Additionally, ethical approval was obtained from the Aksaray University Human Research Ethics Committee with the letter dated 20.06.2023 and numbered E-34183927-000-00000838482.

Data Collection Tools

The surveys and scales used in the study were created in a computerized format and administered through Google Forms. Descriptions regarding the applied surveys and scales were provided. Data collection took place between June 2023 and September 2023.

Socio-demographic data; were obtained through a 13-item questionnaire prepared by the research team. In these questions, data such as the child's age, height, weight, gender, parents' ages, and educational backgrounds have been queried.

Food Frequency Questionnaire Survey (FFQ); queried the participants about their general dietary patterns and the frequency of consuming various food groups, taking into consideration the overall nutrition patterns of the participating children. The validation study of the survey was conducted by Guneş et al. (2016).

The Children's Sleep Habits Questionnaire Short Form (CSHQ); was developed by Owens et al. (2000) in the year 2000 to investigate children's sleep habits and related issues (Owens et al., 2000). The Children's Sleep Habits Questionnaire-Short Form consists of a total of 33 items. The scale defines a total of eleven sub-dimensions, including difficulty waking up in the morning, parasomnias related to sleep fragmentation, sleep anxiety, sleep-related breathing disturbance, other parasomnias, waking up in the morning, sleep duration, sleep onset, the need to sleep with others, daytime sleepiness, and bedwetting at night. The items in the scale are evaluated on a 3-point

Likert system. The cut-off score of the scale is 41. A high total CSHQ score indicates poor sleep quality (Owens et al., 2000).

Statistical analysis

The statistical analysis of the data obtained in the research was conducted using the SPSS 26.0 (Statistical Package for Social Sciences) statistical software package. Categorical variables are presented with the count (n) and percentage (%), while numerical variables are provided with the mean (X) and standard deviation (SD) values. Before analyzing the data, the skewness and kurtosis values of the data were checked. Fisher exact test was used for the variable of food consumption frequencies according to the sports participation status of children with autism. An independent samples t-test was employed for the assessment of sleep habits between the groups of those who engage in sports and those who do not. The significance level for the analyses was set at 0.05. Cohen's d value was calculated to determine the effect size. Cohen's effect sizes were interpreted as follows: $d < 0.2$: trivial, $d < 0.5$: small effect, $d < 0.8$: medium effect, and $d > 0.8$: large effect. (Cohen, 1988).

Results

Sociodemographic Characteristics of Children with Autism

The sociodemographic characteristics of the children with autism included in the study, categorized by age groups within the 3–18 age range, are presented in Table 1. In our study, 29.4% of the participants are female, while 79.6% are male children with autism.

Table 1. Some Sociodemographic Characteristics of Children with Autism by Age Groups

Sociodemographic Characteristics		3–5 n (%)	6–8 n (%)	9–11 n (%)	12–14 n (%)	15–18 n (%)
Gender	Female 19 (20.4)	1 (6.2)	5 (21.7)	4 (28.5)	5 (18.5)	4 (30.7)
	Male 74 (79.6)	15 (93.7)	18 (78.2)	10 (71.4)	22 (81.4)	9 (69.2)
Height	$\bar{X}$	111.1	123.2	140.6	157.4	167.5
	Min–max	85–120	100–150	120–165	130–184	135–188
Body weight	$\bar{X}$	19.4	26.0	40.5	56.4	66.8
	Min–Max	12–30	16–52	26–76	26–100	45–85
Number of Children in the Family	1 Child	5 (31.2)	7 (30.4)	3 (21.4)	7 (25.9)	3 (23.0)
	2 Children	5 (31.2)	10 (43.4)	4 (28.5)	11 (40.7)	5 (38.4)
	3 Children	3 (18.7)	6 (26.0)	4 (28.5)	8 (29.6)	2(15.3)
	4 Children and Above	3 (18.7)	–	3 (21.4)	1 (3.7)	3 (23.0)
Age (Mother)	<25	–	–	–	3 (11.1)	–
	25–35	8 (50.0)	10 (43.4)	2 (14.2)	2 (7.4)	2 (15.3)
	>35	8 (50.0)	13 (56.5)	12 (85.7)	22 (8.1)	11(84.6)

Age (Father)	<25	–	–	–	–	–
	25–35	4 (25.0)	7(30.4)	1 (7.1)	1 (3.7)	–
	>35	12(75.0)	16 (69.5)	13 (92.8)	26 (96.3)	13 (100)
Education (Mother)	Postgraduate	1 (6.2)	3 (13.0)	1 (7.1)	1 (3.7)	2 (15.3)
	Undergraduate	6 (37.5)	8 (34.7)	4 (28.5)	11 (40.7)	6 (46.1)
	High School	4 (25.0)	8 (34.7)	5 (35.7)	10 (37.0)	4 (30.7)
	Primary School	4 (25.0)	4 (17.3)	3 (21.4)	5 (18.5)	1 (7.6)
	Non completed Primary school	1 (6.2)	–	1 (7.1)	–	–
Education (Father)	Postgraduate	2 (12.5)	4 (17.3)	–	1 (3.7)	2 (15.3)
	Undergraduate	3 (18.7)	6 (26.0)	4 (28.5)	13 (48.1)	5 (38.4)
	High School	5 (31.2)	9 (39.1)	5 (35.7)	7 (25.9)	5 (38.4)
	Primary School	6 (37.5)	4 (17.3)	5 (35.7)	6 (22.2)	1 (7.6)
Employment Status (Mother)	Working	4 (25.0)	6 (26.0)	3 (21.4)	7 (25.9)	2 (15.4)
	Non Working	12 (75.0)	17 (73.9)	11 (78.6)	20 (74.0)	11 (84.6)
Employment Status (Father)	Working	15 (93.7)	21 (91.3)	12 (85.7)	26 (96.3)	1 (3.7)
	Non Working	1 (6.2)	2 (8.7)	2 (14.3)	10 (76.9)	3 (23.1)

Dietary Habits of Children with Autism

The dietary habits of children with autism included in the study, categorized by age groups within the 3–18 age range, are presented in Table 2. When the number of meals consumed by children with autism was examined, it was found that the rate of consuming three meals per day was 80.9% for those who engaged in sports three days a week, and 76.4% for those who did not engage in sports three days a week. Among children with autism, 28.57% of those who participate in sports three times a week skip snacks while 33.33% of children with autism who do not engage in sports three days a week skip snacks. When examining the place of eating, 7.1% of children with autism engaged in sports and 11.7% of those not engaged in sports prefer eating while moving.

When examining the issues related to the quantity of food and beverage consumed by children with autism, 4.7% of those engaging sports and 9.8% of those non sports were observed to consume smaller bites and sips than normal. When evaluating the problems encountered by children with autism during meals, it was determined that 7.1% of those sports and 17.6% of those non sports experience difficulty in chewing and swallowing food (Table 2).

Table 2. Dietary Habits of Children with Autism Based on Their Participation in Sports

	3–5 n (%)	Sports n = 42				Non–sports n = 51				
		3–5 n (%)	6–8 n (%)	9–11 n (%)	12–14 n (%)	15–18 n (%)	3–5 n (%)	6–8 n (%)	9–11 n (%)	12–14 n (%)	15–18 n (%)
Number of meals per day	1 meal	–	–	–	–	–	1 (6.2)	–	1 (7.1)	–	–
	2 meal	1 (6.2)	2 (8.7)	–	4 (14.8)	1 (7.6)	4 (25)	3 (13.0)	–	1 (3.7)	1 (7.6)
	3 meal	4 (25.0)	11 (47.8)	5 (35.7)	6 (22.2)	8 (61.5)	6 (37.5)	7 (30.4)	8 (57.1)	15 (55.5)	3 (23.0)

Number of skipped meals	Morning	2 (14.2)	3 (16.6)	1 (7.1)	1 (5.8)	2 (18.1)	1 (7.1)	1 (5.5)	3 (21.4)	1 (5.8)	2 (18.1)
	Lunch	2 (14.2)	2 (11.1)	–	3 (17.6)	3 (27.2)	4 (28.5)	5 (27.7)	2 (14.2)	4 (23.5)	1 (9.0)
	Evening	–	1 (5.5)	–	–	–	–	–	1 (7.1)	–	–
	Snack	–	3 (16.6)	4 (28.5)	3 (17.6)	2 (18.1)	5 (35.7)	3 (16.6)	3(21.4)	5 (29.4)	1(9.0)
Reasons for skipping meals	Due to forgetting or not finding the opportunity	1 (7.1)	1 (5.8)	1 (7.6)	3 (17.6)	3 (30.0)	2 (14.2)	–	1 (7.6)	2 (11.7)	1 (10.0)
	Because of not wanting to	3 (21.4)	6 (35.2)	4 (30.7)	3 (17.6)	3 (30.0)	8 (57.1)	7 (41.1)	6 (46.1)	7 (41.1)	3 (30.0)
	Because of not being hungry	–	2 (11.7)	–	1 (5.8)	–	–	1 (5.8)	1 (7.6)	1 (5.8)	–
Place of eating	At the table	4 (25.0)	10 (43.4)	4(28.5)	9 (33.3)	8 (61.5)	8 (50.0)	7 (30.4)	5 (35.7)	13 (48.1)	3 (23.0)
	On the floor	–	2 (8.7)	–	1 (3.7)	1 (7.6)	–	2 (8.7)	3 (21.4)	2 (7.4)	–
	Standing up	–	–	–	–	–	1 (6.2)	–		–	1 (7.6)
	While walking	1 (6.2)	1 (4.3)	1 (7.1)	–	–	2 (12.5)	1 (4.3)	1 (7.1)	2(7.4)	–
Eating style	Granular	–	3 (13.0)	1 (7.1)	1 (3.7)	1 (7.6)	5 (31.2)	2 (8.7)	2 (14.2)	4 (14.8)	–
	Puree	–	–	–	–	–	–	–	–	–	–
	Liquid	1 (6.2)	–	1 (7.1)	–	1 (7.6)	2 (12.5)	–	–	–	–
	All	4 (25.0)	10 (43.4)	3 (21.4)	9 (33.3)	7 (53.8)	4 (25.0)	8 (34.7)	7 (50.0)	13 (48.1)	4 (30.7)
Person Feeding the Child	**Self Feeding**	3 (18.7)	6 (26.0)	1 (7.1)	5 (18.5)	6 (46.1)	3 (18.7)	5 (21.7)	5 (35.7)	13(48.1)	2 (15.3)
	Mother	–	2 (8.7)	1 (7.1)	–	–	2 (12.5)	5 (21.7)	1 (7.1)	–	–
	Sometimes self. sometimes mother	2 (12.5)	4 (17.3)	3 (21.4)	5 (18.5)	3 (23.0)	6 (37.5)	–	3 (21.4)	3 (11.1)	1 (7.6)
	With the help of other family members	–	1 (4.3)	–	–	–	–	–	–	1 (3.7)	1 (7.6)
Problems with the amount of food and beverages	**None**	4 (25.0)	11 (47.8)	3 (21.4)	8 (29.6)	4 (30.7)	5 (31.2)	8 (34.7)	7 (50.0)	12(44.4)	–
	Very serious restrictive eating	–	1 (4.3)	1 (7.1)	–	–	2 (12.5)	1 (4.3)	–	–	–
	Very large bites and sips	1 (6.2)	–	–	2 (7.4)	5 (38.4)	3 (18.7)	–	–	4 (14.8)	4 (30.7)
	Very small bites and sips	–	1 (4.3)	1 (7.1)	–	–	1 (6.2)	1 (4.3)	2 (14.2)	1 (3.7)	–

Problems Encountered During Feeding	None	5 (31.2)	11 (47.8)	4 (28.5)	6 (22.2)	5 (38.4)	8 (50.0)	9 (39.1)	7 (50.0)	8 (29.6)	1 (7.6)
	Vomiting	–	–	–	–	–	–	–	–	–	–
	Rumination	–	–	–	–	1 (7.6)	–	1 (4.3)	–	–	—
	Pica	–	–	–	–	–	–	–	–	–	–
	Spitting out food	–	1 (4.3)	–	1 (3.7)	–	–	–	–	–	–
	Food pouching	–	–	–	–	–	–	–	1 (7.1)	1 (3.7)	–
	Swallowing without chewing	–	–	–	–	3 (23.0)	1 (6.2)	–	–	5 (18.5)	3 (23.0)
	Talking persistently about food	–	–	–	–	–	–	–	–	–	–
	Playing with food	–	–	–	3 (11.1)	–	–	–	–	1 (3.7)	–
	Multiple problems	–	1 (4.3)	1 (7.1)	–	–	2 (12.5)	–	1 (7.1)	2 (7.4)	–

When the frequency of food consumption among autistic children was evaluated, it was found that the rate of daily consumption of milk and dairy products was 52.3% for children who engage in sports, whereas the rate for children who do not engage in sports is 45.1%. When vegetable and fruit consumption was examined, daily consumption rates were higher in children who engage in sports. However, this difference was not found to be statistically significant ($p > 0.05$). The daily egg consumption rate for children who engage in sports is 61.9%, whereas it is 37.2% for children who do not engage in sports. This difference is statistically significant ($p < 0.05$) (Table 3).

Table 3. Food Consumption Frequencies of Children with Autism According to Their Sports Activity

Food Groups	Sports n = 42				Non–Sports n = 51				p
	None n %	everyday n %	1–2 times/week n %	1 times/ month n %	None n %	everyday n %	1–2 times/ week n %	1 times/month n %	
Dairy products (Yogurt, Kefir etc.)	8 19.0	22 52.3	12 28.5	– –	16 31.3	23 45.1	10 19.6	2 3.9	.684
Meat Products (fish, chicken, offal, etc.)	7 16.6	14 33.3	21 50.0	–	9 17.6	12 23.5	27 52.9	3 5.8	.238

Egg	8 19.0	26 61.9	6 14.2	2 4.7	13 25.4	19 37.2	16 31.3	3 5.8	**.049***
Legumes (beans, chickpeas, lentils, etc.)	7 16.6	13 30.9	21 50.0	1 2.3	15 29.4	7 13.7	24 47.0	5 9.8	.100
Vegetable	6 14.2	17 40.4	16 38.1	3 7.1	16 31.3	15 29.4	19 37.2	1 1.9	.108
Fruit	3 7.1	33 78.5	5 11.9	1 2.3	9 17.6	30 58.8	9 17.6	3 5.8	.182
Bread and Cereal (pasta, rice, etc.)	1 2.3	31 73.8	9 21.4	1 2.3	2 3.9	38 74.5	9 17.6	2 3.9	.921
Oil (butter, oil, walnuts, almonds, olives)	3 7.1	27 64.2	8 19.0	4 9.5	11 21.5	30 58.8	8 15.6	2 3.9	.448

Fisher's exact test, *p < 0,05

Evaluating the Sleep Patterns of Children with Autism

When the sleep status of children with autism was examined according to their age, the CSHQ score of 3–5 year old children who did non-sports was found to be 49.54 ±8.09, which was significantly higher than that of 3–5 year old children who did sports ($p < 0.05$; $d = 1.71$). In contrast to this situation, the average scores of 12–14 year old children participating in sports on the CSHQ were found to be 50.1 ±8.33, and this was significantly higher than those of 12–14 year-old children who did non-sports ($p < 0.05$; $d = 0.98$) (Table 4).

Table 4. Comparison of CSHQ Total Scores in Children with Autism Based on Their Engagement in Sports Activities

Age Group	Sports n = 42		Non–sports n = 51		t	p	Effect Size
	CSHQ $\bar{X}$ ±SD	CSHQ Median (Min–Max)	CSHQ $\bar{X}$ ±SD	CSHQ Median (Min–Max)			
3–5 (n = 16)	39.4 ±2.0	39 (37–42)	49.5 ±8.0	47 (40–62)	–2.715	**0.017**	1.71
6–8 (n = 23)	43.3 ±4.5	45 (36–51)	43.1 ±6.3	41 (36–57)	0.091	0.928	0.03
9–11 (n = 14)	51.8 ±15.3	46 (37–74)	48.6 ±6.4	50 (38–56)	0.544	0.596	0.26
12–14 (n = 27)	50.1 ±8.3	50 (39–61)	41.5 ±8.8	41 (31–65)	2.456	**0.021**	0.98
15–18 (n = 13)	44.2 ±12.5	38 (33–67)	45.2 ±8.9	42 (39–58)	–0.146	0.887	0.09

When the sleep habits of children with autism were evaluated according to their engagement in sports activities, no significant difference was observed between the groups ($p > 0.05$). However, children who did not participate in sports had higher CSHQ average scores in terms of sleep onset delay, sleep duration, and nighttime awakenings compared to children engaged in sports (Table 5).

Table 5. Comparison of Subscale Groups of Sleep Habits in Children with Autism Based on Their Engagement in Sports Activities

CSHQ Subscales	Sports (n = 42)	Non Sports (n = 51)	t	p	Effect Size
	CSHQ $\bar{X}$ ±SD	CSHQ $\bar{X}$ ±SD			
Bedtime resistance	10.6 ±3.2	10.0 ±3.3	0.738	0.462	0.17
Sleep onset delay	1.6 ±0.7	1.6 ±0.7	–0.052	0.958	0.01
Sleep duration	3.9 ±1.3	4.0 ±1.2	–0.160	0.873	0.04
Sleep anxiety	6.7 ±2.0	6.6 ±2.3	0.292	0.771	0.06
Night wakings	3.8 ±1.1	4.3 ±1.5	–1.884	0.063	0.33
Parasomnias	8.7 ±2.5	8.6 ±1.9	–0.208	0.836	0.02
Sleep–disordered breathing	3.8 ±1.2	3.6 ±0.9	1.021	0.310	0.21
Daytime sleepiness	10 ±2.6	9.7 ±2.7	0.420	0.675	0.08
Mean Scale Scores	45.6 ±9.4	45.1 ±8.2	0.285	0.776	0.05

Discussion

Irregular feeding behavior limited physical activity and sleep disturbances are all risks that threaten healthy living in children with ASD (Curtin et al., 2014; Dhaliwal et al., 2019; Matheson & Douglas, 2017; Srinivasan et al., 2014). It is undeniable that researchers need more studies that comprehensively describe the lifestyle factors of children with ASD. Within this scope, some eating habits, nutritional problems, food consumption frequencies, and sleep habits of children with ASD have been assessed.

It is known that the risk of experiencing nutritional problems in children with autism is significantly higher (approximately five times) compared to their peers (Sharp et al., 2013). Findings from recent studies suggest that problems such as being selective towards a particular food or food group, showing sensitivity, and rejecting food often result in various nutritional issues, leading to eating behavior disorders and inadequate nutrient intake (Berding & Donovan, 2016).

When studies investigating eating habits in children with autism are evaluated, the habit of having three main meals is common (Kaynar & Yılmaz, 2020; Şengüzel et al., 2021, Shaly & Sreesna, 2013). When we examined the meal frequencies of the children with autism included in our study, the rate of consuming three meals for those engaged in sports was found to be 80.9%, while the rate for those not engaged in sports was 76.4%. Of the children with autism who engage in sports three days a week, 28.57% skip snacks. In comparison, 33.33% of children with autism who do not engage in sports three days a week skip snacks (Table 2). A study found that, 38% of children with ASD require assistance from their parents while eating, and 30% can eat on their own (Bicer & Alsaffar 2013), In our study, it was observed that 52.68% of children with autism can eat on their own, while 47.32% require assistance while eating. The inclusion of children with a lower age range may have an impact on the lower percentage. It is generally accepted that many children with ASD have unique food preferences and unusual eating behaviors (Schreck & Williams, 2006).

It has been also shown that regular exercises applied to children with autism have positive behavioral, cognitive and social effects (Hynes & Block, 2023). It is generally known that many children with ASD have unique food preferences and unusual eating behaviors (Schreck & Williams, 2006). In our study, it was observed that children with ASD who practiced sports 3 days a week had lower rates of very severely limited eating, very large bites and sips, and very small bites and sips compared to children who did not practice sports 3 days a week (Table 2). Our study is consistent with the view that sports activities have a significant relationship with oral motor skills.

According to a study addressing the feeding problems of children with ASD, the most common problem, with a rate of 30%, was found to be the children's food choices. Of the participating children with autism, 24% were reported to eat quickly, and 24% to eat excessively. The rates for difficulty transitioning to table meals, gagging/coughing during meals, and refusing meals were observed as 17%, 17%, and 16%, respectively (Zeybek & Yurttagül, 2020). In another study, it was found that 45% of children with ASD vomit during meals, and 56% retain food in their mouths (Siddiqi et al., 2019). In our study, vomiting during meals was not observed. Food retention in the mouth was observed in 2.15% of children with ASD. None of the children with autism participating in our study exclusively consumed pureed food, and it was observed that 5.37% of them consumed only liquid food. Children with ASD were found to have a high probability of accepting only low-texture foods, such as pureed foods. Researchers have concluded that children with autism exhibit significantly greater food selectivity compared to typically developing children (Zeybek & Yurttagül, 2020). In our study, 74.19% of children with ASD consume all types of food. In the study conducted Demir and Ozcan (2022) involving children with ASD and a control group, it was shown that 71.2%

of children with ASD ate at the table, while 91% of the control group ate at the table. This difference was found to be statistically significant. In our study, 76.3% of children with ASD eat their meals at the table.

In a study on the frequency of food consumption in children with autism, it was observed that 57.1% of the children reject vegetables, and 32.1% reject fruits (Zeybek & Yurttagül, 2020). In a conducted study, it was found that children with ASD consume fewer vegetables, fruits, and dairy products compared to their typically developing peers (Sharp et al., 2013). In a study examining the frequency of food consumption among children with ASD aged 2–13 in India, it was found that the consumption of fruits, green leafy vegetables, and other vegetables was low, while the consumption of grains (mainly white and brown rice) was high. Additionally, it was determined that milk consumption is infrequent (Siddiqi et al., 2019). A meta-analysis study also reported that children with autism consume lower levels of fruits and vegetables (Esteban-Figuerola et al., 2019). In our study, the daily consumption rates of vegetables and fruits for children who sports were found to be 40.47% and 78.58%, respectively. The daily fruit and vegetable consumption rates of children with autism who non sports were found to be 29.4% and 58.8%, respectively. In a study, the daily egg consumption of children with autism was 37.01 ±55.37 g, while it was 27.37 ±18.79 g for children with typical development, but the result did not show a statistically significant difference (Mendive Dubourdieu et al., 2022). In another epidemiological study, the daily egg consumption of preschool children with autism was 12.15 g, while it was 17.79 g in typically developing children (Canals-Sans et al., 2022). In our study, when the egg consumption frequency of children with autism was examined, the daily egg consumption rate of children who sports was 61.9%, while the daily egg consumption rate of children with autism who did not do sports was found to be 37.2% (Table 3). Most research has focused on non-disabled children (Zhu et al., 2024; Tournier et al., 2024). This results in a deficiency of research on effective interventions for children with autism. This gap limits the opportunity to reduce health risks related to nutrition in the population. The understanding and increased feasibility of adequate and balanced nutrition according to parents of children with autism will contribute to improving the quality of life and prevent public health issues.

Physical activity, children's nutrition, and sleep habits are recognized as promising approaches for improving sleep quality. Research has shown that participation in physical activity has a positive impact on the health, sleep patterns, and overall quality of life of individuals with ASD (Liang et al., 2024). Recently, most research has emphasized the importance of practices that promote sports for individuals with ASD. It was reported that sports may have a positive effect on the health, sleep patterns, and quality of life of individuals with ASD. It has been also observed that improvement in sleep quality has a positive effect on individuals' problematic behaviors, and improvements in cognitive-executive dimensions and motor functions (Cohen et al., 2014; Gómez et al., 2020).

In a study conducted on 40 children with autism aged 6–14 years, participants in the experimental group practiced water-based activities for 2 sessions/60 minutes per week for 10 weeks and it was concluded that these activities can improve sleep quality in children (Sikora et al., 2012). In another study conducted on 6 children with autism between the ages of 4–13 years, 30 minutes of in-water exercise was applied to children and no statistically significant difference was found between sleep quality between nights with and without exercise (Wilson, 2019). In our study, the mean CSHQ score of children with ASD aged 3–5 years who practiced sports 3 days a week was found to be significantly lower than children with ASD aged 3–5 years who did not practice sports 3 days a week, while the mean CSHQ score of children aged 12–14 years who practiced sports 3 days a week was found to be higher ($p < 0.05$, ES = 0.98) (Table 4). Although this situation partially contradicts the literature, it may be due to the difficulty of observing 12–14-year-old children accurately because the data were collected through parents.

Our study provides concrete data in terms of observing the score difference by giving the CSHQ score of each age group according to sportive activities. In one study, researchers aimed to compare the sleep quality and quality of life of children who participated in regular physical activity and those who did not, and found no significant difference in sleep patterns or sleep habits between the two groups (Seferoğlu & Güral, 2022). Because of the difficulty in estimating when a person has fallen asleep, more and more people have begun to adopt device-based sleep measurements to provide more accurate estimates (Wang et al., 2024).

Individuals with autism in different age groups are more likely to have various sleep disorders and limited sleep duration (Hand et al., 2020; Lugo et al., 2020). In our study, it was concluded that children who did not practice sports 3 days a week had higher mean scores in sleep duration and night awakenings CSHQ compared to children who did practice sports 3 days a week (Table 5). In line with our findings, research has shown that combined aerobic exercise (AET) and motor skills training increased sleep efficiency, shortened the delay in sleep onset, and decreased the awakening time after falling asleep in 63% of the sample in the nights following AET and MS (Brand et al., 2015). Another study examined the effect of physical activity on sleep and behavioral functioning in children aged 8–12 years with autism spectrum disorder and confirmed the benefits of exercise on sleep duration and behavioral functions in children with autism spectrum disorder (Tse et al., 2022). Wachob and Lorenzi (2015) found that children who were more physically active had less difficulty falling asleep and their sleep patterns were less disrupted in 10 children with autism aged 9–16 years. Research has shown that 12-week basketball training for children with autism improves sleep quality (Tse et al., 2022) and a 4-week swimming program reduces the time to fall asleep (Oriel et al., 2016). Therefore, it can be said that there is an important relationship between physical activity and sleeping habits.

Several limitations should be considered when interpreting the results of this study. Initially, the reliance on parent-reported data as the only source for children's sleep and dietary issues, along with contributing factors, presents a potential concern. It is important to acknowledge that parents might either minimize or overstate their children's difficulties in these areas. Furthermore, the accuracy of parental recollections could influence the perceived connection between eating and sleep disturbances. Another constraint is the absence of comparative data from typically developing children or other children with special needs, which limits the ability to contextualize the findings. Additionally, this cross-sectional study design prevents the observation of changes in sleep or eating patterns over time. Finally, the assessment of physical activity levels, which depended on participant memory and self-reporting, introduces a potential for inaccuracies due to recall bias.

Conclusion

The current findings reveal differences in dietary habits, food consumption frequencies, and sleep habits among children with autism based on their engagement in sports activities. Our study shows that participation in sports activities three times per week is associated with a higher frequency of egg consumption and more regular eating habits in children with autism. These findings suggest that involvement in sports activities may serve as a promising strategy for regulating the sleep patterns and nutritional intake of children with autism, thereby potentially enhancing overall sleep quality.

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