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Food Selectivity And Gait In Children With Autism

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Abstract

Background:*Food selectivity is an emerging health concern among children with autism spectrum disorder (ASD). Food selectivity is used to describe food refusal, limited food choices, and/or food fussiness.*

Method:*In this context, the authors paid attention to food selectivity and its possible correlation with the food selectivity in children with autism and it's affection on gait . This research included the parents or caregivers of pediatric patients diagnosed with autism spectrum disorder and placed within a therapeutic clinic. The sample is composed of 50 children's with autism.*

Result:*50 cases were included 20 of them had food selectivity , there is a significant difference between positive food selection and negative ones regarding weight and BMI. there is a significant association between BMI with Fruit and vegetables and both . there is a significant difference between the studied groups regarding Juice and sweetened non-dairy beverages, vegetables, and Energy-dense snacks.The results revealed that bases of support left & right, and double support left & right [1]were significantly higher among positive patients compared to negative patients. However, Cadence was significantly lower among positive patients compared to negative patients. there is a significant correlation between BMI with cadence, right & left bases of support and double support.*

Conclusion: *The present study revealed a number of differences in temporal parameters of walking between positive and negative children that could disadvantage the obese in movement tasks. The unreliability of gait patterning observed in obese children (slower walking velocities, shorter stride lengths, and increase in base of support and longer double support percentages) is related to body composition and is affected by speed of walking. Walking is a fundamental movement pattern, the most common form of physical activity. The results of this study may provide useful information to the clinician evaluating walking characteristics of child gait with autism and his food selectivity character*

Keywords: *autism, gait , selectivity, food.*

Introduction

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Food selectivity is a common issue among children with autism spectrum disorder . This term encompasses various situations and behaviors, including rejecting certain foods, aversion to specific flavors, colors, textures, or temperatures, and sticking to a diet limited to specific food categories. Food packaging and presentation can also play a role . Difficulty transitioning from paste to solid foods may be an early sign of a symptom of autism, such as restricted and stereotyped interests, which can manifest as pervasive eating disorders. Food selectivity is not limited to food refusal and lack of variety, but also includes a restricted diet of fewer than 8–20 dishes, indicating a strong rigidity in food choices and a poor acceptance of new foods (Alibrandi A et al.,2023)

Childhood overweight and obesity affect over 30% of children .The consequences of childhood overweight and obesity are significant, including cardiovascular risk factors, type 2 diabetes, menstrual abnormalities, sleep apnea, and psychosocial effects . Overweight and obesity affect children of all races, ethnicities, and socioeconomic strata, including children with chronic conditions and developmental disabilities. One such group of children is those with autism spectrum disorders (ASD). Estimates from 2006 suggest that ASD affects 1 in 110 children in the United States, a prevalence that has quadrupled over the last two decades (Center for Disease Control and Prevention .(Sahoo K et al.,2015)

A few studies have examined the weight status of children with ASD. Analyses of the National Survey of Children's Health have shown the prevalence of obesity among children with ASD was at least as high as among other children . Three other small, non-representative samples have also documented that obesity is common in children with ASD . Despite these findings that suggest that children with ASD are at risk for overweight and obesity, it is not known whether the risk factors in this population are different from those that have been identified for children overall.(Curtin C et al.2014), on the other hand the dietary contributors to childhood overweight and obesity were examined and evidence of typically developing children suggests that dietary contributors to caloric imbalance include increased consumption of sugar-sweetened beverages (Calcaterra V et al.,2023)

The presence of an unusual walking style, or gait abnormalities, in individuals with autism begin early in life and are often noted by clinicians. At a qualitative level, gait in autism has been described as uncoordinated and disjointed. These gait abnormalities have been linked to the basal ganglia and/or cerebellum . The precise role of these two structures in gait are not completely understood. However, in general terms gait abnormalities may linked to increase body mass index due to food selectivity in autism children (Kindregan D et al.,2015), so the aim of this study to assess gait abnormalities with food selectivity in children with autism

Patients and methods

Participants

50 Participants included children with ASD and typically developing children .

Participants were excluded if they had been diagnosed with a disease or disorder that affects dietary and/or physical activity habits (e.g. diabetes, heart disease, or other chronic diseases, significant vision or hearing impairment, chronic GI illnesses that affect food intake, and cerebral palsy), or if they were taking medications known to have an impact on appetite, such as steroids, atypical antipsychotics, mood stabilizers, tricyclic antidepressants, anticonvulsants, and stimulants. Diagnoses of children with ASD were confirmed using the Autism Diagnostic Interview – Revised (ADI-R) (Rutter, Le Couteur, & Lord, 2003).

Anthropometry measures

All study participants (child and at least one parent) completed one study visit during which they were weighed and measured, and parents were asked to complete several questionnaires. Each child and their parent(s) were weighed in light clothing without shoes using a Seca™ portable scale and measured using a wall-mounted stadiometer. If both parents were not present at the study visit, the present parent was asked to obtain the absent parent's height and weight using a provided form and pre-paid envelope for return by mail.

Body mass index (BMI, kg/m2) was calculated for children and their parents from measures of heights and weights. Children's gender- and age-specific BMI z-scores and corresponding percentiles were calculated relative to the US CDC 2000 growth charts (Kuczmarski, Ogden, Guo, Grummar- Strawn, & Mei, 2002; National Center for Health Statistics, 2009).

Overweight was defined as at or above the 85th percentile, obesity was defined as at or above the 95th percentile, and underweight was defined as less than the 5th percentile(Barlow, 2007; Ogden).

Food selectivity.

At child age 4.0 ± 0.1 years, food selectivity was measured via the 6-item "food fussiness" subscale from the parent-reported Children's Eating Behaviour Questionnaire (CEBQ). The CEBQ has good test-retest reliability and internal consistency . Items were anchored on a 5-point Likert scale from 1 (never) to 5 (always) and summed.(Wardle J et al.,2001)

Iron Concentration:

Reference Value: Serum Iron (SI): Children: 50 to 120 μg/dL (Ginder GD., 2011).

Procedure: Iron concentration was determined by colorimetry with bath of phenanthroline. Transferrin-bound iron was released using sodium dodecyl sulphate (SDS) and reduced to Fe^{2+} using hydroxylamine (Skrzypczak WF et al., 2009). The reagent samples were incubated at 37°C for 20 min.

The absorbance read reagent sample at the wave length λ=535 nm. Iron concentrations in the plasma were read from the calibration curve (Lai Y., 2012).

- Zn concentration (Zinc assay Kit):

Reference Values: reference range $\geq$ 11 years: 0.66-1.10 mcg/mL i.e. (60-120 μg/dL) Procedure: Three (3) samples of acidified zinc solutions were provided for analysis, labeled A, B and C. The concentrations of each solution were provided by two methods; Titrimetry and Flame atomic absorption spectrometry, to ensure the accuracy of the generated results.

The instrument used for gait analysis:

Gait analysis was quantified by the new anatomically based protocol of three-dimensional kinematical gait analysis system. Distance and time parameters in hemiparesis cerebral palsy and healthy children were identified and calculated.Kinematic motion analysis system during gait cycle was done in motion analysis laboratory at the Delta University for Science & Technology which is equipped with a walkway and six infrared cameras operating at 60 HZ frequency. In addition, two Force plates embedded at the center of the walkway were used to determine the foot contact and foot-off events synchronized with the system made from motion analysis Company (Helen Hayes model).

Ethical approval

The study protocol was approved by Medicine Ethical committee, and parents consent was taken

Statistical Analyses

All analyses were conducted using SPSS 23 version, with statistical significance set at $p<0.05$. Comparisons between children with ASD with positive selectivity and negative food selectivity were made using t-tests for continuous variables and Chi-square or Fisher's exact test for categorical variables.

Result

Children were divided into two groups according to mean food selectivity scores to positive food selectivity group 20/50 and negative food selectivity group mean food selectivity score was (19.5 compared with 17.7, respectively < 0.001)

Table 1. Baseline characteristics between the two studied groups.

	Positive (n=20)	Negative (n=30)	P
Age (years)	7.36 ± 2.14	7.54 ± 2.05	.766
Weight (kg)	74.2 ± 16.62	52.1 ± 9.88	**<0.001**
BMI (kg/m^2)	28.79 ± 4.03	21.24 ± 2.83	**<0.001**
Gender, n(%)			
Male	15 (75)	21 (70)	.700
Female	5 (25)	9 (30)	
BMI Categories, n(%)			
Underweight	0	6 (20)	**<0.001**
Normal weight	3 (15)	15 (50)	
Overweight	3 (15)	5 (16.7)	
Obese	14 (70)	3 (10)	
Serum iron (ug/dl)	61.5+3.65	66.8+4.32	0.042
Serum zinc (mg/dl)	54.3+5.65	70.6+6.22	0.001

BMI: body mass index.
Quantitative data were expressed as mean ± SD and tested using Independent-T test.
Qualitative data were represented as numbers and percentages and tested Chi-square test.

We found that there is a significant difference between positive food selection and negative ones regarding weight and BMI.

And there was significant decrease in serum iron and zinc level in cases with food selectivity versus non food selectivity cases

Table 2. daily servings of dietary patterns distribution.

	Positive (n=20)	Negative (n=30)	P-value
Juice and sweetened non-dairy beverages	2.8 ± 2.34	1.64 ± 1.48	**.037**
Vegetables	1.41 ± 1.26	2.13 ± 1.27	**.016**
Fruits	1.67 ± 1.49	2.25 ± 1.23	.143
Energy-dense snacks	4.03 ± 2.35	3.06 ± 1.56	**.025**
Kid’s meals	1.08 ± 0.722	1.05 ± 0.519	.648

This table shows that there is a significant difference between the studied groups regarding Juice and sweetened non-dairy beverages, vegetables, and Energy-dense snacks.

Table 3. Association between dietary patterns and BMI.

	β	S.E.	P-value
Juice and sweetened non-dairy beverages	.113	.062	.103
Fruit & vegetables	.152	.046	**.003**
Vegetables	.134	.083	**.038**
Fruits	.167	.049	**.006**
Energy-dense snacks	.043	.056	.411
Kid’s meals	-.062	.23	.431

This table shows that there is a significant association between BMI with Fruit and vegetables and both.

Table 4. Gait parameters distribution between the two studied groups.

	Positive (n=20)	Negative (n=30)	P
Cadence (steps/min)	112.58 ± 9.41	118.62 ± 11.71	**.049**
Velocity (cm/s)	134.06 ± 15.31	141.59 ± 18.29	.135
Step length left (cm)	68.49 ± 5.81	70.32 ± 6.12	.296
Step length right (cm)	68.75 ± 5.87	71.41 ± 6.25	.138
Stride length left (cm)	139.4 ± 12.1	145.7 ± 12.43	.082
Stride length right (cm)	138.87 ± 11.94	144.8 ± 12.35	.098
Gait cycle time left (sec)	1.11 ± 0.973	1.08 ± 0.107	.867
Gait cycle time right (sec)	1.12 ± 0.13	1.1 ± 0.192	.686
Base of support left (cm)	11.41 ± 2.35	8.66 ± 3.18	**.002**
Base of support right (cm)	11.25 ± 2.57	8.52 ± 2.91	**.001**
Double support left (%GC)	25.79 ± 3.05	22.73 ± 3.1	**.001**
Double support right (%GC)	26.12 ± 3.1	22.56 ± 3.06	**.001**

Quantitative data were expressed as mean ± SD and tested using Independent-T test.
The results revealed that bases of support left & right, and double support left & right were significantly higher among positive patients compared to negative patients. However, Cadence was significantly lower among positive patients compared to negative patients.

Table 5. Correlation between BMI and Gait parameters.

	r	P-value
Cadence (steps/min)	.351	**.028**
Velocity (cm/s)	.281	.258
Step length left (cm)	.256	.321
Step length right (cm)	.325	.257
Stride length left (cm)	.061	.810
Stride length right (cm)	.177	.496
Gait cycle time left (sec)	.136	.642
Gait cycle time right (sec)	.234	.154
Base of support left (cm)	.389	**.016**
Base of support right (cm)	.407	**.008**

Double support left (%GC)	.425	**<0.001**
Double support right (%GC)	.434	**<0.001**

This table shows that there is a significant correlation between BMI with cadence, right & left bases of support and double support.

Discussion

In the current study we found that significant difference between positive food selection and negative ones regarding weight and BMI.

Although food selectivity might be expected to limit intake and result in inadequate weight gain, we hypothesized that higher intake levels of energy dense foods (juice and sweetened non-dairy beverages, snacks, and "kids' meals") and lower intake of fruits and vegetables in children with ASD compared to typically developing children would be associated differentially with BMI z-score across groups. This hypothesis is consistent with the findings that children with ASD prefer energy dense foods (Ahearn WH et al., 2001; Schreck KA et al .,2006) along with previous findings that energy dense foods are associated with increased caloric intake (Rolls BJ et al.,2005).

In the current study we found that there is a significant difference between the studied groups regarding Juice and sweetened non-dairy beverages, vegetables, and Energy-dense snacks.In the current study we found that there is a significant difference between the studied groups regarding Juice and sweetened non-dairy beverages, vegetables, and Energy-dense snacks.

several previous studies that have found an association between sugar-sweetened beverage consumption and overweight and obesity (Ebbeling CB et al., 2006; **Lise D** et al., 2007; **Ludwig DS** et al., 2001). A recent study found that sugar-sweetened beverage intake accounts for between 10% to 15% of caloric intake in typically developing children and adolescents in the U.S. (Wang YC et al., 2008). Decreasing consumption of sugar sweetened beverages is an established modifiable risk factor for overweight and obesity in typically developing children (Wang YC et al., 2008). Additionally, sweetened beverage consumption reduces intake of important nutrients (Vartanian L et al .,2007) and is associated with lower bone density in female adolescents (Wang YC et al., 2008).

Perhaps most unexpected was the finding that fruit intake as well as fruit and vegetable intake were positively associated with BMI z-score when controlling for ASD and parental obesity. We examined the combined fruit and vegetable category because dietary guidance often focus on them as a single dietary target

Obesity is clinically implicated with musculoskeletal disorders involving the back, hip, knee, ankle and foot . In the current study we found that bases of support left & right, and double support left & right were significantly higher among positive patients compared to negative patients. However, Cadence was significantly lower among positive patients compared to negative patients. there is a significant correlation between BMI with cadence, right & left bases of support and double support

The observed statistical significance between two groups of children for base of support can be a factor contributing to increased stability during walking especially for the overweight/obese population at different speeds. Another factor to consider relative to obesity and gait is that with an increase in BMI, there is an accumulation of adipose tissue, which leads to an increase in thigh circumference. The increased thigh circumference necessitates circumduction of the leg with each stride. This might also be a reason for increased base of support for the overweight/obese group.

The gait pattern adapted by overweight/obese children might be related to an increased need for stabilization and settling of the body structures caused by obesity. A wider base of support as suggested by De Souza et al., (2005) can be seen as the consequence of obesity overloading the lower limbs, as the body fights to keep upright by separating the knees and ankles, in order to achieve a lower center of gravity and more anterior-posterior and lateral stability

A possible explanation for the significance observed in double support percentage for the right limb in both preferred and fast speeds, as well as the time spent in base of support for the right limb during fast walking indicated greater asymmetry for the right limbs. This phenomenon was suggested by Hills and Parker (1991), which noted that overweight/obese children showed greater asymmetry in gait than non-obese children, consistently favoring the right limb. Velocity is without a doubt also an important factor when predicting BMI, in this study the preferred speed for overweight/obese children was lower (117.39 ± 16.06 cm/s) vs. non-obese children (122.47 ± 17.68 cm/s). Although velocity did not enter the fast speed model, a similar measure (cycle time) did.

Another explanation was the significant decrease in serum iron and zinc level in cases with food selectivity versus non food selectivity cases which affects gait in our study and was proved as several minerals play a role in muscle metabolism and muscle function. For example, calcium, potassium, and sodium are necessary for healthy muscle and nerve activity, and magnesium is thought to have a positive effect on muscle relaxation and could improve muscle function. Low iron blood serum concentrations are thought to be associated with poor physical performance.10 A lack of phosphorus can lead to muscle weakness, whereas selenium deficiency is associated with several muscular diseases. Zinc is able to delay oxidative processes, which are known to contribute to disuse muscle atrophy.(Van Dronkelaar C et al.,2018)

Conclusion

The present study revealed a number of differences in temporal parameters of walking between positive and negative children that could disadvantage the obese in movement tasks. The unreliability of gait patterning observed in obese children (slower walking velocities, shorter stride lengths, and increase in base of support and longer double support percentages) is related to body composition and is affected by speed of walking. Walking is a fundamental movement pattern, the most common form of physical activity. The results of this study may provide useful information to the clinician evaluating walking characteristics of child gait with autism and his food selectivity character

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