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Comparing the gross motor performance levels of 7–10 age group children with autism spectrum disorder and typical developing

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Abstract

Background and Study Aim The children and adolescents with Autism Spectrum Disorder lead a sedentary lifestyle and, as a result, they are more affected by health problems such as being overweight and obese. They are physically less active than their peers showing typical developing. The aim of the study is to carry out a general comparison of the gross motor performance levels of elementary school-age children living in Germany diagnosed with autism spectrum disorder and children showing typical developing.

Material and Methods A total of 68 children diagnosed with autism spectrum disorder and 73 children showing normal development between the ages 7 and 10 participated in the study. Of the participants, 55 were diagnosed with autism spectrum disorder were boys and 13 were girls, and the average age of the boys was 8.40±1.09 years, while the average age of the girls was 8.85±1.14 years. Of the 73 participants, 36 showing typical development consisted of boys and 37 of them consisted of girl students, and the average age of the boys was 8.56±1.08 years while the average age of the girls was 8.43±1.21 years. The Body Coordination Test for Children was used to evaluate gross motor performance components in the study.

Results The results of the study showed that girls had lower general body coordination than boys on average. It was concluded that children who had an autism spectrum disorder diagnosis displayed statistically lower total motor performance in all of the administered tests compared to their peers showing normal development ($p<0.05$).

Conclusions It is considered that the data obtained will provide important clues about the motor coordination values and body composition of children with autism spectrum disorder and will contribute to taking precautions against the health risks of children with autism spectrum disorder, who are more affected by a sedentary lifestyle compared to their normally developing peers.

Keywords: autism spectrum disorder, epilepsy, epileptic seizures, physical activity

Introduction

It is estimated that the prevalence of autism spectrum disorder (ASD) is approximately 4% worldwide. However, the diagnosis rate is between 0.3% and 1.0% [1]. While an ASD diagnosis was given to one in every 10000 people in the 1980s, it is estimated that one in 125 people in 2004 and 1 in 59 people in 2018 were diagnosed with ASD [2]. As the incidence and diagnosis rate of ASD increases, it can be observed that interest relating to the health and development of these individuals has also increased. In the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5), ASD is evaluated as a neurodevelopmental disorder characterized by differences in social communication skills, sensory processing difficulties, restricting and repetitive behaviors and verbal or nonverbal deficiencies [1, 3]. Deficiencies and difficulties are seen in language and communication skills, social skills and social behaviors in the diagnosed individuals [4-6]. In addition to these characteristics, it is stated that individuals with ASD may experience delays, troubles and deficiencies in their development of motor behavior [7-8], and motor limitations can be commonly observed regardless of the presence of mental disability [9]. It is also observed that diagnosed children and adolescents are more affected by a sedentary lifestyle due to the difficulties they encounter in the communication, social, behavioral and motor domains [10-11].

It is estimated that adolescents with ASD leading sedentary lifestyles [10-11] are also subject to health problems such as being overweight or obese, and that their risk probability is higher than their peers showing typical developing [10, 12-13]. It is emphasized that obesity, which has tripled in the last two decades, has become an important health problem for children [14], and it is thought that this rate may increase in those leading a sedentary lifestyle.

Studies that investigated the relationship between physical activity and motor proficiency have shown that children and adolescents with ASD who are

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affected by a sedentary lifestyle are physically less active than their peers showing typical developing [13,15-17]. It has been observed that the trainer, the place that an activity takes place [18], social circles [19], family [20], transportation difficulties [21], number of activities and inadequacies in variety [22] are among the important factors that affect participation in an activity. As a result of inadequate participation in an activity, individuals with ASD have a higher probability of facing difficulties in gross and fine motor skills [23], gross motor performance [7, 24], balance [17, 25], throwing and catching [4, 26], flexibility [27-28], posture [29], walking [30] and movement speed [28, 31] and thus, have lower gross motor performance [7, 24] when compared to their peers showing typical developing.

Motor proficiency is accepted as an important part of motor development [32]. Although it is not a definitive criterion for determining diagnosis, 83% of children with ASD have difficulty performing age-appropriate motor skills [27, 33] and that motoric delays are frequently observed [4, 9, 17, 23, 27, 33]. As such, timely and correct intervention has an important role in eliminating or reducing these difficulties. It is also thought that being able to diagnose only 0.3% to 1.0% of the prevalence rate of about 4% worldwide [1] delays the initiation of intervention programs such as physical activity, and that this delay makes it difficult for children and adolescents with ASD to live healthy lives. Thus, early diagnosis is crucial to alleviate and eliminate symptoms [35]. Motoric tests can help determine the diagnosis and motor proficiency should be included when determining diagnoses [36].

In recent years, sports sciences have made significant progress in their field and developed tests that help evaluate motor proficiency simply and objectively. The primary aim of these tests is to help detect children and adolescents who have motor development disorders and troubles (32). Moreover, such methods used in a similar way should be applicable to the widest possible age range, be economical and the type that children would enjoy [37].

A review of existing literature shows that different tests are used to determine the gross motor performance levels of children and adolescents. However, there are a few test batteries in which gross motor skills are determined with the same test in both children and adolescents with typical developing and those with disabilities or impairments and motoric problems. Although The Body Coordination Test for Children (Körperkoordination Test für Kinder=KTK) is one of these, it has been seen that the studies conducted mostly focus on children and adolescents showing typical developing.

Hypothesis. The children and adolescents with ASD lead a sedentary lifestyle and, as a result, they are more affected by health problems such as being overweight and obese. This study, assuming that the general gross motor performance scores of children with an ASD diagnosis would be lower than their peers showing typical developing.

Purpose. The aim of the study is to carry out a general comparison of the gross motor performance levels of elementary school-age children of 7–10 age living in Germany diagnosed with ASD and children showing typical development (TD).

Materials and Methods

Participants.

The participants consisted of a total of 141 elementary school-age students, 68 diagnosed with ASD (*DSM* 5 299.00) [1] and 73 showing typical developing, living in Germany between the ages of 7 and 10.

Of the participants, 55 were diagnosed with ASD were boys and 13 were girls, and the average age of the boys was 8.40±1.09 years, while the average age of the girls was 8.85±1.14 years.

It was determined that 68 students were diagnosed with mild ASD from their identification cards issued by local governments. According to the psychiatric or medical diagnosis report, a mental disability accompanying ASD and a secondary obstacle restricting participation in physical activity were not encountered. Of the 73 participants, 36 showing typical developing consisted of boys and 37 of them consisted of girl students, and the average age of the boys was 8.56±1.08 years while the average age of the girls was 8.43±1.21 years. The 68 students with an ASD diagnosis constituted the ASD group, the 73 students showing typical developing constituted the TD group. Acute diseases, injuries, the usage of antidepressants, chronic inflammations, medication usage affecting the muscle/bone system and their simultaneous inclusion in another test were used as exclusion criteria from the study.

Data collection was performed in accordance with the provisions of "Federal Data Protection Act" (BDSG). The required approvals were obtained from relevant federation and Germany TV Eberbach Health, Rehabilitation and Disability Sport Department (TVE/GS 2018-3011). Participation in the study was voluntary, families were informed about the aims, content and data protection of the study according to the Helsinki Declaration and a signed parent consent form was obtained from the families.

Research Design

Procedures: Before the study, in order to determine the ASD group, a prepared informational brochure was given to families of children with ASD in the cities of Heidelberg and Eberbach, Germany, and its surroundings, through the school the students attend and the Rehabilitation Sports Club. A total of 179 brochures were distributed and

feedback was received from 83 families. A total of 83 families were informed about the inclusion criteria of the children in the study, either face-to-face or by phone, and information about the children's health status was obtained. After the briefing, 15 people with epilepsy, mental or physical disabilities, using antidepressants and drugs affecting the muscle/bone system or chronic inflammation, who were simultaneously involved in another sports test were not included in the study, and an ASD group of 68 was created. To determine the TD group, families who were a member of TV Eberbach Sports Club were informed via email, and feedback was received from 81 families. A 73 people TD group was created due to eight students being unable to participate in the test due to various reasons such as illness, injuries, etc. The application of the tests were conducted by an instructor (researcher) with a rehabilitation sports license in the neurology, orthopedics, sensory and mental domains.

Data Collection Tools: KTK was used to evaluate gross motor performance components in the study. The KTK applied by Kiphard and Schilling [37-38] is commonly used in Germany to determine the gross motor performance in children and adolescents between the ages of 5 and 14 showing typical developing with brain damage and behavioral disorders. It is evaluated as a test that is applied very easily by taking simple precautions and with very low operating costs (39).

KTK consists of four sub-tests measuring total gross motor performance:

(1) Backstepping (MQ1): Three trials were made for varying widths on the basis of stepping backwards on a balance beam of 6 cm, 4.5 cm and 3 cm width, 5 cm height and 3 m length. Each trial has a maximum of eight points and is based on a maximum possible score of 72 points.

(2) One-foot jump (MQ2): Three trials were made for each height in the test performed with the principle of jumping with one foot over a total of 12 (50 cm x 20 cm x 5 cm) sponges. The 7–8 age group started with three (15 cm) sponges while the 9–10 age group started with five (25 cm) sponges, and another sponge was added after each successful trial. Three, two and one point was given to performances that were successful on the first, second and third trials, respectively. The maximum test score was 39 points for each leg, reaching a total of 78 points for both legs.

(3) Sideways jump (MQ3): A springboard (100 cm x 60 cm) fixed to the ground is divided into two from the middle with a lath (60 cm x 4 cm). The participants were asked to jump right and left over the lath as quickly as possible within 15 seconds and the total number of jumps was recorded.

(4) Sideways stepping (MQ4): Non-slip feet-shaped markers with a height of 3.7 cm were attached on the bottom of two wooden platforms measuring 25 cm x 25 cm x 1.5 cm. The test started when the child was on a platform and they were asked to switch to the empty platform by putting their hands on the side. This application continued for 20 seconds and a second trial started after an interval of at least 10 seconds. The total number of successful switches at the end of two trials were recorded [37-38].

For the application of KTK, the children were taken into a hall in small groups of 2–3 people in the ASD group and 4–5 people in the TD group. The test's procedure was explained by the researcher and practically demonstrated, following which the participants were allowed to do a trial for each test item. The test application started when the students were certain about how the test works. The same student did not do all of the test items back to back. It was passed on to the next student after each test item, and thus, the opportunity to rest between the test items was provided. This cycle continued until the four test items were completed.

According to Kiphard and Schilling [37-38], the raw scores are inadequate to evaluate the results. In order to conduct the evaluation, each test item was converted to norm values in accordance with the original manual of KTK, and the total motor values (TMQ) were determined by combining norm values. In the evaluation, *out of classification* (< 56), *distinct impairment* (56–70), *inadequate* (71–85), *normal* (86–115), *good* (116–130) and *high* (131–145) estimated motor performance classification made through *standard motor values* (MQ) [37-38].

Body Mass Index (BMI), applied to obtain information about the participants' body composition and determined by standardized height and weight measurements, was found to be highly reliable (Doolittle et al., 1969). The measurements were made using the height and body mass Seca 769 digital weight/height measurement tool. BMI was calculated using the formula BMI = Body Mass (kg.)/Height square (m^2) from the obtained data. The interpretation and classification of the BMI percentage values were determined using the AGA reference values, the most common method of determining obesity in Germany [40].

According to the WHO [41] standards, slim, normal weight, overweight and obese classifications were used when looking at the BMI values.

Statistical Analysis

The SPSS 26 program for Mac was used in the analysis of the data. Kolmogorov–Smirnov test was used to determine whether the data fit normal distribution, alongside skewness-kurtosis values and histogram graphs, which are other assumptions of normal distributions. The distribution of the data was accepted as normal because the skewness–kurtosis values were within the range of ±2 [42]. A

t-test (independent samples t-test) was used in the comparison of two independent groups, one-way variance analysis was used in the comparison of two or more groups. The relationship between variables was analyzed using the Pearson correlation coefficient. The significance level of 0.05 was used as the criterion for the interpretation of the values obtained.

Results

Upon examining Table 1, it can be seen that 21.8% of the boys with ASD who participated in the study had normal weight, 61.8% of them were overweight and 16.4% were obese. Further, 23.1% of the girls in this group had normal weight, 61.5% of them were overweight and 15.4% were obese. On the other hand, 55.6% of the boys in the TD group had normal weight, 41.7% of them were overweight and 2.8% were obese, while 78.4% of the girls had normal weight and 21.6% of them were overweight. Overall a total of 21.1% of the children in the ASD group had normal weight, 61.8% of them were overweight and 16.2% were obese, while a total of 76.1% of the children in the TD group had normal weight, 31.5% were overweight and 1.4% were obese.

Whether the measurement values used in the study differed significantly according to the groups and gender was examined with an independent samples t-test. According to the obtained data (Table 2), it was determined that the MQ1, MQ2, MQ3, MQ4 and TMQ measurement values did show a statistically significant difference according to groups ($p < 0.05$).

MQ1 values show a statistically significant difference between groups [$t(139)=-26.37$ $p<0.05$]. It can be seen that the children in the ASD group (65,75±6,29) have lower values of the MQ1 measurement values compared to the children in the TD group (104,52±10,50). The calculated MQ1 ($\eta 2 = 0.83$), effect size value show that the differences between the groups are ample. It can be said that 83% of the variance change in the MQ1 values is caused by the differences between the groups.

MQ2 values show a statistically significant difference between groups [$t(139)=-14.98$ $p<0.05$]. It can be seen that the children in the ASD group (61.10±6.93) have lower values of the MQ2 measurement values compared to the children in the TD group (88.93±13.77). The calculated MQ2 ($\eta 2 = 0.62$), effect size value show that the differences between the groups are ample. It can be said that 62% of the variance change in the MQ2 values is caused by the differences between the groups.

Table 1. Percentage values of normal weight, overweight and obese classes of the ASD and TD Groups

		Normal Weight		Overweight		Obese	
Variables	**Gender**	**N**	**%**	**N**	**%**	**N**	**%**
ASD Group	Boys n=55	12	21.8	34	61.8	9	16.4
	Gils n=13	3	23.1	8	61.5	2	15.4
	Total	15	22.1	42	61.8	11	16.2
TD Group	Boys n=36	20	55.6	15	41.7	1	2.8
	Girls n=37	29	78.4	8	21.6	-	-
	Total	49	67.1	23	31.5	1	1.4

ASD: Autism Spectrum Disorder, TD: Typical developing

Table 2. Results of Comparing Measurement Values According to Groups (Independent Samples T-Test)

Variables	**Groups**	**n**	**M±SD**	**t**	**df**	**p**	**η2**
MQ1	ASD	68	65.75±6.29	-26.37	139	0.01	0.83
	TD	73	104.52±10.50				
MQ2	ASD	68	61.10±6.93	-14.98	139	0.01	0.62
	TD	73	88.93±13.77				
MQ3	ASD	68	54.99±9.38	-16.50	139	0.01	0.66
	TD	73	89.36±14.60				
MQ4	ASD	68	56.22±10.19	-17.77	139	0.01	0.69
	TD	73	94.64±14.87				
TMQ	ASD	68	71.87±5.61	-12.02	139	0.01	0.51
	TD	73	92.95±13.41				

ASD: Autism spectrum disorder, TD: Typical developing, M: Mean, SD: Standard deviation, BMI: Body mass index (weight/height^2), MQ1: Motor values/backstepping, MQ2: Motor values/one-foot jump, MQ3: Motor values/sideways jump, MQ4: Motor values/sideways stepping, TMQ: Total motor values

MQ3 values show a statistically significant difference between groups [t(139)=-16.50 p<0.05]. It can be seen that the children in the ASD group (54.99±9.38) have lower values of the MQ3 measurement values compared to the children in the TD group (89.36±14.60). The calculated MQ1 (η2 = 0.66), effect size value show that the differences between the groups are ample. It can be said that 66% of the variance change in the MQ3 values is caused by the differences between the groups.

MQ4 values show a statistically significant difference between groups [t(139)=-17.77 p<0.05]. It can be seen that the children in the ASD group (56.22±10.19) have lower values of the MQ3 measurement values compared to the children in the TD group (94.64±14.87). The calculated MQ4 (η2 = 0.69), effect size value show that the differences between the groups are ample. It can be said that 69% of the variance change in the MQ4 values is caused by the differences between the groups.

TMQ values show a statistically significant difference between groups [t(139)=-12.02 p<0.05]. It can be seen that the children in the ASD group (71.87±5.61) have lower values of the TMQ measurement values compared to the children in the TD group (92.95±13.41). The calculated TMQ (η2 = 0.51), effect size value show that the differences between the groups are ample. It can be said that 51% of the variance change in the MQ1 values is caused by the differences between the groups.

According to the data specified in Table 3, it was determined that the MQ1, MQ2, MQ3, MQ4 and TMQ measurement values did show a statistically significant difference according to gender (p<0.05). When the average values are examined, it can be observed that boys have a higher average gross motor performance score as compared to girls in all of the tests.

As with the original research, engine performance was classified as *unclassified* (56), *significant disorder* (56 – 70), *insufficient* (71 – 85), *normal* (86 – 115), *good* (116 – 130), and *advanced* (131 – 145) over the standard MQ values (Table 4).

According to the classification, 12.7% of the boys with ASD were "unclassified" and 87.3% were in the "significant disorder" category, while 76.9% of the girls with ADS were "unclassified" and 23.1% were in the "significant disorder" category. 16.7% of boys with typical development scored "inadequate", 83.3% scored "normal", while 10.8% of girls scored "significant disorder", 46% scored "inadequate", and 43.2% scored "normal". In general, 25% of ASD participants performed "out of classification", while 75% demonstrated "significant disorder". While 5.5% of participants in the typical development group demonstrated "significant disorder", 31.5% demonstrated "inadequate" performance, and 63% demonstrated "normal" performance. According to

Table 3. Results of Comparing the ASD/TD Groups Measurement Values According to Gender

Items	Groups	Gender	n	M±SD	t	df	p	η2
MQ1	ASD	Boys	55	67.11±5.78	4.07	66	0.01	0.20
		Girls	13	60.00±5.13				
	TD	Boys	36	108.47±9.33	3.40	71	0.01	0.14
		Girls	37	100.68±10.24				
MQ2	ASD	Boys	55	62.69±6.19	4.38	66	0.01	0.22
		Girls	13	54.38±5.95				
	TD	Boys	36	96.08±12.25	5.07	71	0.01	0.26
		Girls	37	81.97±11.52				
MQ3	ASD	Boys	55	57.65±7.77	5.93	66	0.01	0.34
		Girls	13	43.69±7.03				
	TD	Boys	36	97.36±11.36	5.47	71	0.01	0.29
		Girls	37	81.57±13.20				
MQ4	ASD	Boys	55	59.04±9.05	5.67	66	0.01	0.32
		Girls	13	44.31±4.64				
	TD	Boys	36	98.14±14.27	2.12	71	0.04	0.05
		Girls	37	91.24±14.85				
TMQ	ASD	Boys	55	73.87±3.87	8.97	66	0.01	0.54
		Girls	13	63.38±3.43				
	TD	Boys	36	100.58±11.80	5.78	71	0.01	0.32
		Girls	37	85.51±10.44				

*p<0.05, M: Mean, SD: Standard deviation, BMI: Body mass index (weight/height^2), Min.: Minimum, Max.: Maximum, ASD: Autism spectrum disorder, TD: Typical developing, MQ1: Motor values/backstepping, MQ2: Motor values/one-foot jump, MQ3: Motor values/sideways jump, MQ4: Motor values/sideways stepping, TMQ: Total motor values

these findings, children with typical development have higher values than children with ASD, and girls have lower values in both groups. According to the classification identified, it can be interpreted that children with ASD exhibited *inadequate* performance but had a higher tendency towards the *distinct impairment* category, while children with TD exhibited *normal* performance, but had a higher tendency towards the *inadequate* category.

The relationship between variables was examined using the Pearson correlation coefficient (Table 5). While there was no statistically significant relationship between age and the MQ1, MQ3, MQ4 and TMQ variables ($p > 0.05$), it was determined that there was a statistically low significant negative correlation between age and MQ2 values ($r = -0.20$, $p < 0.05$). It was determined that there is a statistically low significant negative correlation between BMI values and the MQ1, MQ2, MQ3, MQ4 and TMQ values ($p < 0.05$).

A one-way ANOVA test was used to compare the measurement values used in the study according to BMI categories and the Bonferroni multiple comparison test, a post-hoc test, was used to determine which motor performance categories the difference was in (Table 6).

MQ1 values show a statistically significant difference according to BMI classes [$F(2,138)=16.91$ $p<0.05$]. According to the Bonferroni multiple comparison tests used to determine which BMI classes differ, people with normal weights have significantly higher MQ1 values than those who are overweight or obese.

MQ2 values show a statistically significant difference according to BMI classes [$F(2,138)=5.92$ $p<0.05$]. According to the Bonferroni multiple comparison tests used to determine which BMI classes differ, people with normal weights have significantly higher MQ2 values than those who are overweight or obese.

Table 4..The results of a comparison of performance classification values by group and gender.

		ASD Group		TG Group	
Gender	**Performance Categories**	**N**	**%**	**N**	**%**
Boys	unclassified (<56)	7	12,7	0	0
	significant disorder (56-70)	48	87,3	0	0
	insufficient (71-85)	0	0	6	16.7
	normal (86-115)	0	0	30	83.3
Girls	unclassified (<56)	10	76,9	0	0
	significant disorder (56-70)	3	23,1	4	10.8
	insufficient (71-85)	0	0	17	46
	normal (86-115)	0	0	16	43.2
Boys/Girls Total/	unclassified (<56)	17	25	0	0
	significant disorder (56-70)	51	75	4	5.5
	insufficient (71-85)	0	0	23	31.5
	normal (86-115)	0	0	46	63
	Total	68	100	73	100

ASD: Autism spectrum disorder TD: Typical developing.

Table 5. Examining the Relationship between Variables

Items		**Age**	**BKI**
MQ1	r	0.09	-0.25
	p	0.29	0.01*
MQ2	r	-0.20	-0.25
	p	0.02*	0.01*
MQ3	r	-0.08	-0.28
	p	0.32	0.01*
MQ4	r	0.02	-0.27
	p	0.79	0.01*
TMQ	r	-0.03	-0.22
	p	0.74	0.01*

*p<0.05, BMI: Body mass index (weight/height^2), MQ1: Motor values/backstepping, MQ2: Motor values/ one-foot jump, MQ3: Motor values/sideways jump, MQ4: Motor values/sideways stepping, TMQ: Total motor values

Table 6. Results of Comparing the Measurement Values According to the KTK Motoric Performance Categories

Items	Groups	M±SD	Coefficient of Variance	Sum of squares	df	Mean of squares	F	p	η2	Post hoc
	Normal Weight[1]	95.54±19.22	Between Groups	12500.673	2	6250.337				
MQ1	Overweight[2]	79.59±20.11	Within Group	50999.894	138	369.564	16.91	0.01	0.19	1>2.3
	Obese[3]	67.75±12.92	Total	63500.567	140					
	Normal Weight[1]	80.78±16.86	Between Groups	3488.364	2	1744.182				
MQ2	Overweight[2]	71.88±18.20	Within Group	40654.870	138	294.601	5.92	0.01	0.07	1>2.3
	Obese[3]	67.08±11.82	Total	44143.234	140					
	Normal Weight[1]	80.48±20.31	Between Groups	7782.965	2	3891.483				
MQ3	Overweight[2]	67.78±20.29	Within Group	55049.219	138	398.907	9.75	0.01	0.12	1>2.3
	Obese[3]	58.75±15.68	Total	62832.184	140					
	Normal Weight[1]	85.23±22.06	Between Groups	10310.604	2	5155.302				
MQ4	Overweight[2]	69.69±22.25	Within Group	64553.581	138	467.780	11.02	0.01	0.13	1>2.3
	Obese[3]	62.25±14.15	Total	74864.184	140					
	Normal Weight[1]	87.32±15.20	Between Groups	2623.979	2	1311.989				
TMQ	Overweight[2]	79.69±13.95	Within Group	28066.206	138	203.378	6.45	0.02	0.08	1>2.3
	Obese[3]	75.25±9.71	Total	30690.184	140					

M: Mean, SD: Standard deviation, 1 MQ1: Motor values/backstepping, MQ2: Motor values/one-foot jump, MQ3: Motor values/sideways jump, MQ4: Motor values/sideways stepping, TMQ: Total motor values

MQ3 values show a statistically significant difference according to BMI classes [$F(2,138)=9.75$ $p<0.05$]. According to the Bonferroni multiple comparison tests used to determine which BMI classes differ, people with normal weights have significantly higher MQ3 values than those who are overweight or obese

MQ4 values show a statistically significant difference according to BMI classes [$F(2,138)=11.02$ $p<0.05$]. According to the Bonferroni multiple comparison tests used to determine which BMI classes differ, people with normal weights have significantly higher MQ4 values than those who are overweight or obese.

TMQ values show a statistically significant difference according to BMI classes [$F(2,138)=6.45$ $p<0.05$]. According to the Bonferroni multiple comparison tests used to determine which BMI classes differ, people with normal weights have significantly higher TMQ values than those who are overweight or obese.

Discussion

The aim of the study was to compare the general gross motor performance levels of children diagnosed with ASD and children showing typical developing in the elementary school-age bracket through KTK, which has been evaluated as a test that is very easy to apply, with very low activity cost and simple precautions. It was seen that children diagnosed with ASD had higher BMI values after KTK, and that in all of the applied tests (backstepping, one-foot jump, sideways jump, sideways stepping), children diagnosed with ASD displayed lower motor performance compared to their peers showing typical developing. It was concluded from the obtained data that the girls participating in the study had lower overall body coordination than boys, on average.

Studies have reported that children and adolescents with ASD lead a sedentary lifestyle and, as a result, they are more affected by health problems such as being overweight and obese [10-11], and that the probability of being overweight and obese was higher in children diagnosed with ASD compared to their peers showing typical developing [12-13, 43]. Moreover, the results reported in the limited number of studies in which the BMI values of children with ASD are determined, differ from each other. In a study Takeuchi [44] conducted with a group of 13 people diagnosed with ASD, it was stated that the BMI values of the participants were low. However, in their study conducted with a group of 17 people, Tyler et al. [45] reported that the BMI values were normal. In a study conducted with a larger sample group, Egan et al. [46] evaluated 273 children with ASD and stated that 17% of the participants were overweight and approximately 22% of them were obese. Similarly, in a study they conducted with 429 children with ASD in the age group 6–11, Xiong et al. [47] stated that 51% of the participants were overweight or obese. Curtin et al. [48] also examined obesity in children with ASD and found that the probability of being obese was 40% higher in children with ASD as compared to children showing typical developing. In this study, it was observed that 78% of children with ASD and 32.9% of the children showing typical developing were overweight and obese, while the results strengthen the assumption that children with ASD

have a higher risk of obesity and being overweight. Thus, the data obtained support the results of other studies [48-51].

Further, in general, it has been reported that children and adolescents diagnosed with ASD participate in physical activity to a limited extent [4, 52-53]. In studies investigating the relationship between physical activity, motor proficiency [4, 13, 15-17, 33, 49, 52, 54] and gross motor performance [7, 24], it was found that the gross motor performance of adolescents with ASD, who are affected by a sedentary lifestyle, were lower than their peers showing typical developing and the reported results are parallel to those in this study [55-56]. In their study, Kiphard and Schilling [37] obtained a general (gender and all age groups) 100±15 TMQ value. While results close to the Germany-based sample were reported in similar studies [57-60], lower TMQ values were reported in some studies [61-62] and higher values were reported in others [63-64]. In this study, it is seen that the TMQ values of the ASD and TD groups differ from other studies as they remain below the KTK norm values reported by Kiphard and Schilling [37]. Staples and Reid [34] observed in their study, with 25 children diagnosed with ASD in the 9–12 age group, that the diagnosed children attained lower values compared to their age. In a similar study, Freitag et al. [65] stated that individuals who were diagnosed with Asperger syndrome had low gross motor performance and reported results parallel to this current study.

Performance differences between genders were observed in some of the conducted studies. Antunes et al. [66], stated that boys displayed higher performance compared to girls in the backwards balancing and stepping sideways tests. In a study they conducted, Fransen et al. [67] and Hardman et al. [60] obtained higher values in girls compared to boys in the backwards balancing test; however, they stated that boys displayed overall higher performance compared to girls in other parts of the test. In this study, it was also determined that boys attained higher TMQ values as compared to girls and results similar to other studies were obtained.

In a study where an eight-week traditional dance program was given to 10 adolescents diagnosed with ASD, Arzoglou et al. [68] tried to determine the gross motor performance of the participants with KTK. They reported that the TMQ values were lower than the standard norm values. The TMQ values in this study were also determined to be lower, which is consistent with the results of other such studies.

Conclusion and Suggestions

This study was designed about an important area such as ASD, which has increasingly become the subject of research in recent years. It aims to shed light on future research and support the existing database by comparing the gross motor performance of children with an ASD diagnosis and children showing typical developing. As a result of this study, it was determined that children with ASD were overweight and obese when compared to their peers showing typical developing. From these results, it is thought that children with ASD are at a higher risk for obesity and being overweight. The obtained data show that the gross motor performance of children with ASD is lower than their peers showing typical developing, and that girls had lower TMQ scores compared to boys in both groups. However, although it was found that children with ASD had lower TMQ scores, this result should not be interpreted as children showing typical developing do not have gross motor performance problems. It was found that children showing typical developing also had TMQ scores under the standard norm values, suggesting that the gross motor performance problem is not solely caused by ASD.

It should be noted that the conducted study was limited to a relatively small sample and only focused on children living in Germany. As such, future studies that study international, more ethnically diverse and more comprehensive samples are needed alongside experimental studies to recommend KTK in determining gross motor performance in children with ASD, following which the current study's results can be verifiable. Simultaneously, it is recommended that clinicians diagnosing and treating children with ASD additionally evaluate motor coordination deficits and take early intervention precautions for motor problems to contribute towards eliminating these problems.

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Conflicting interest

The author declares no conflict of interest.

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