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The Relationship Between Motor Competence, Body Composition, Handgrip Strength and Sports Participation Among Icelandic Adolescents

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A B S T R A C T

Motor competence can affect participation in sports and physical activity among adolescents. The aim of the current study was to investigate the relationship between motor competence, body composition, handgrip strength (HGS) and sports participation in 13-16 years old adolescents, as well as to examine gender differences. Data for 177 boys and 153 girls were collected and analysed. Body composition was assessed by measuring height, weight, waist circumference, body fat percentage (FAT%), and calculating body mass index (BMI). Motor competence was determined by using the Movement Assessment Battery test (MABC-2) which consists of eight tasks that measure aiming and catching, balance, and manual dexterity. Handgrip strength was assessed by using hand dynamometer and the question about sports participation was retained from a detailed questionnaire for the current study. The results of the study show that girls have better motor competence in the 13-, 14- and 15-year-old age groups (13 years girls: 10.3, boys: 8.7; 14 years girls: 10.3, boys: 9.2; 15 years girls: 10.1, boys: 8.6, respectively), but there was no significant difference between the genders in the 16-year-old age group (girls: 9.6, boys: 9.0, respectively). HGS had a positive correlation with FAT% ($r=0.5$, $p<0.05$) and waist circumference in 13- year-old girls ($r=0.5$, $p<0.05$), BMI in boys age of 16 ($r=0.3$, $p<0.05$), and FAT% ($r=0.4$, $p<0.05$) and MABC-2 in girls 16-years old ($r=0.6$, $p<0.05$). Participation in organized sports activities was the most important factor when predicting motor competence in 13- to 16-year-old adolescents ($t=3.7$, $p<0.05$). Future studies should consider the development of gender differences from a long-term perspective, and in that sense, longitudinal studies could give better explanations.

Key words: *adolescence; body composition; gender differences; handgrip strength; motor competence; sports participation*

Introduction

Overweight and obesity, defined by the WHO as the abnormal or excessive accumulation of fat that poses a health risk, is a public health problem, particularly in adolescents. Its prevalence in children and adolescents is highly worrying, as data on paediatric obesity have increased dramatically in recent times. It is estimated that more than 200 million children and adolescents aged 5-19 years will suffer from overweight and obesity in 2025, and this number is expected to rise to 254 million in 2030[1]. Although overweight and obesity have been categorized as multifactorial diseases, physical inactivity is a significant facilitator, with high rates of inactivity found in the European adolescent population[2]. The etiological nexus between overweight, obesity, and physical inactivity is intricately linked to the fundamental principle of energy balance. Regular engagement in physical activity serves as a critical modulator of this equilibrium, expending calories and mitigating the propensity for adipose tissue accumulation, thereby influencing body weight dynamics. Low levels of physical activity (PA) are part of adolescents' health problems today, particularly in females[3]. The increased amount of screen time, sleeping disorders, and lack of motivation to actively engage in PA add to this situation[4]. Moreover, the health benefits of PA include reduced risk of all-cause mortality, lower incidence of heart disease, metabolic and other disorders, and lower levels of overweight and obesity[5].

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Motor competence (MC) can be conceptualized as the person´s ability to perform different movements, including both gross and fine motor skills[6]. The current PA literature has generally yet to focus on the evolutionary nature of MC and its role in promoting PA over time. In essence, researchers have focused on measuring PA in children without understanding that learning to move is a necessary skill underlying PA. Motor competence in children and adolescents is considered a major factor in predicting future physical activity levels and influencing weight status [7]. Mastery of motor skills has been found to contribute significantly to children's physical, cognitive, and social development and to form the foundation for an active lifestyle[8]. The relationship between proper motor development, perceptions of motor competence, and health-related physical fitness in predicting physical activity and obesity from childhood to adulthood should be further explored. Recently, it has been proposed that proper motor development interacts with perceptions of motor competence and health-related physical fitness to predict PA and subsequent obesity from childhood to adulthood[9].MC in children and adolescents may be an essential correlate of subsequent PA and for the development and maintenance of physical fitness (PF)[10]. Development of MC is considered an underlying mechanism that provokes participation in PA and can be a key factor in consequence of one´s weight status[7]. Part of persistent health challenges among adolescents today are low PA[11], particularly among females, and obesity[12]. Gender differences in physical activity and obesity are often attributed to a complex interplay of biological, social, and environmental factors. Biologically, hormonal variations between males and females can influence body composition and fat distribution, potentially contributing to disparities in obesity prevalence. Socially, cultural norms and expectations regarding physical activity may differ for males and females, influencing their engagement in exercise and sports. Additionally, environmental factors such as access to recreational facilities, safety concerns, and societal attitudes can shape opportunities for physical activity and contribute to gender-based variations in obesity rates.

Furthermore, research has shown that excess body mass is an obstacle to the development of MC and the positive effect of MC level on health-related PF[13]. Studies have shown a relationship between low MC in children with increased body mass index (BMI)[14] and negative development between MC and body fat from childhood into adolescence[15]. Another study[16] has shown that children with low MC had a higher risk of obesity than adolescents. Battataglia et al.[17] concluded that overweight and obese children demonstrated significantly lower MC compared to normal-mass peers. It has been documented that being overweight or obese is a major limitation in MC tests and impacts on health and performance-related (PF)[16].

Muscle strength is important because it enhances the quality of life and improves the ability to do everyday activities. A decrease in muscle strength may cause significant functional limitations [18]. In adolescents and adults, handgrip strength (HGS) is considered a reliable measure of whole-body strength. HGS is crucial for the human body when performing prehensile and precision hand functions and it is used as one of the main indicators for testing muscle strength[19]. HGS is an easily obtainable and robust measure of overall muscular strength in humans [18]. The study of Alaniz et al. [20] provides evidence that grip and pinch strength are important components of functional fine motor tasks.

To participate in many sports, the development of MC and proficiency in fundamental motor skills (e.g., jumping, running, kicking, throwing) is important. Children with high MC are more likely to become successful in sports and to continue sport participation than their counterparts with low MC [21]. Participation in sport provides an optimal environment for the development of MC as it promotes the acquisition of fundamental motor skills. Furthermore, sports practice benefits both genders in building MC. Konttinen et al. [22] investigated the sports club participation and its impact on motor competences. Participants who reported organized competitive sports club participation demonstrated higher levels MC than the children, who reported no past sports club involvement. These findings are in line with research work that supports earlier empirical studies suggesting that consistent participation in organized youth sports relates to higher levels of actual and perceived motor skills [23]. Also, adolescence is a transitional phase marked by significant changes in physical, cognitive, and social domains. During this time, individuals often experience rapid growth, hormonal changes, and development of motor skills. Thus, the aim of this study was to investigate the relationship between motor competence, body composition, handgrip strength, and sports participation in 13-16-year-old adolescents, as well as to examine gender differences.

Materials and Methods

Study design and data collection

Conceptually, this is a cross-sectional, descriptive, and quantitative study. All participants answer the questionnaire, performed the Movement Assessment Battery test (MABC-2), the body composition measurement, and handgrip strength measurement during their physical education (PE) classes.

Participants

After ethical approval was received from the National Bioethics Committee of Iceland (Ref: VSNb20170 30026/03.01), all students attending 7th-10th grade (ages 13-16) in two compulsory schools in Reykjavik, Iceland were invited to participate in the study. A total of 387 students expressed interest in participating after ethical approval was obtained. Ultimately, data from 330 adolescents (n=330 complete data) were included in the analysis, including 153 girls and 177 boys. The age range of 13-16 years was selected as it was closest to the aims of the study. All procedures in this study complied with the Declaration of Helsinki. Inclusion criteria for this study consisted of participants, aged 13-16, that had signed informed consent from parents/guardians, attended regular PE classes, and did not have any type of cognitive or physical limitations. Verbal consent was given by the participants, and they were informed that their participation was voluntary and that they could withdraw from the study at any time.

Body composition

Body composition measurement was administered individually in a closed room in the sports hall, and it was assessed by measuring body height, body mass, waist circumference, and body fat (BF%). All measurements were conducted following the International Biological Program – IBP guideline. Body mass and height were measured on calibrated scale (Seca 799 Digital Column Scale, Hamburg, Germany) and stadiometer (PSM® Height Measuring Scale for Adults and Children), respectively. Body mass index (BMI) was calculated based on mass and height by dividing body mass by height squared (kg/m^2). Waist circumference was measured with a non-flexible measure tape (accuracy up to 1 mm). It was assessed where the waist is bounded between the lower rib and the upper edge of the hip ridge. A standard skin thickness gauge was used to measure body fat. Jackson and Pollock 3-Site skinfold equation was used to determine the body fat percentage; therefore, the measurements were taken at chest, abdomen and thigh for males and triceps brachii, suprailiac crest and thigh for females. Participants were in light sportswear and were not wearing shoes at the moment of the measurements.

Movement Assessment Battery test (MABC-2)

The Movement Assessment Battery test (MABC-2) was used as an objective measurement of adolescents' motor competence 6]. The MABC-2 provides an assessment of gross and fine motor coordination and is designed for the age group from 3-16 years. The test provides different tasks for each age group (1-3, 7-10, 11-16 years). For each age group, the individual performance is referenced to a standardization sample of an individual of the same age. The test consists of eight tasks in three motor domains: three tasks measuring manual dexterity (turning pegs/triangles with nuts and bolts/drawing trail); two tasks measuring ball skills (catching with one hand/throwing at wall target); and three tasks measuring balance (two-board balance/walking toe-to-heel backward/zig-zag hopping). For each three motor domains, a standard score was obtained from the norms as well as the total score. A higher total score indicates better motor performance. The total score of the MABC-2 is the sum of the raw scores of the test items, which are then converted into a percentile rank. These percentile ranks are used to categorise individuals into one of three zones: green (> 15th percentile), indicating no movement difficulties; amber (between the 5th and 15th percentile), indicating a potential risk of movement difficulties; and red (< 5th percentile), indicating significant movement difficulties 6].

The eight different MABC-2 tasks were organized in a circuit and administered by a trained assessor as described by Henderson et al. 6]. The Movement Assessment Battery for Children-Second Edition (MABC-2) is administered in a controlled and standardized manner by trained examiners. The test environment is quiet and distraction-free, with adequate space and standardized equipment. Clear and standardized instructions, including demonstrations, were provided to participants. The examiner's role involved scoring based on predetermined criteria, real-time observation, and potential adaptations for individual needs, with training ensuring standardized administration. The duration of the test varies by age group, aiming for completion within a reasonable timeframe to maintain participant engagement. These procedures align with the standardized protocols detailed in the MABC-2 manual, ensuring consistency in assessment across diverse populations and contexts. Participants completed eight stations in the circuit in a pre-given order.

The MABC-2 has good reliability, with a minimum test-retest reliability of 0.77 at each age and an inter-rater reliability of 0.79 6]. In addition, it has been validated against other measures of motor performance, including Bruininks-Oseresky test of motor performance, with a remarkable 80% agreement 24].

Handgrip strength

Handgrip strength was measured for dominant hand by using the analog hand dynamometer (Jamar Hydraulic Hand Dynamometer (5030J1). Participants were instructed how to perform the test. The subject held the dynamometer in the hand to be tested, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer was adjusted to the size of the hand of every participant. The base should rest on the first metacarpal (heel of palm), while the handle should rest on middle of the four fingers. When ready the subject squeezed the dynamometer with maximum isometric effort, which was maintained for about 2 seconds. No other body movement was allowed. The subject received verbal encouragement to give a maximum effort i.e., “grip as strong as possible”.

Sport Participation

Participants answered a detailed questionnaire on sleep, nutrition, motivation, exercise, and only the question concerning their participation in sports at a sports club was retained for the analysis. The following question and scales were used in this study. ‘Do you practice sports at a sports club?’ There were five possible answers: I do not participate in sports, once a week, twice a week, three times a week, four or more times a week (Figure 1).

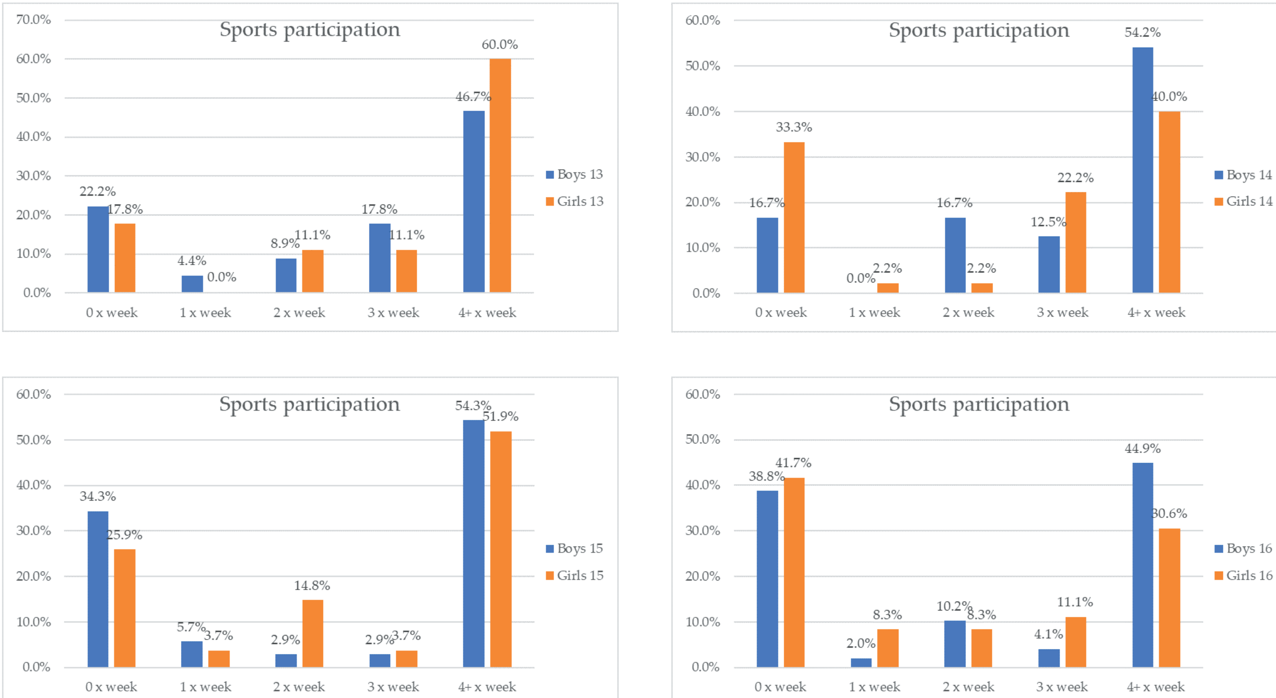

Fig. 1. Participation in sports on a weekly basis.

Statistical Analysis

All statistical analysis was performed using SPSS (V.26 for Windows, IBM). First, descriptive statistics, including means and standard deviations, were presented for motor skills, BF%, BMI, waist circumference, and HGS by age and gender. The correlation between these variables was examined using the Pearson correlation coefficient, and the significance level (p-value), strength and direction of the correlations were assessed. This analysis allowed us to examine the relationships between the different variables in our dataset. A linear regression analysis was conducted to examine the effects of body composition (including variables such as waist circumference, BMI, and BF%) and sport participation on motor competence. This analysis helps us to understand how these factors influence motor competence in our study population. Multivariate analysis of variance (MANOVA) was performed to compare differences, both in the motor skills test and in the sub-components of the test (balance, fine motor skills, throw, and grip), but also in body composition and handgrip strength across the genders and ages, together with Tukey post hoc test. The covariate used was cut on the MABC – 2 motor skills test and the primary variables were gender, age, sports participation, waist circumference, BMI, and BF%.

To examine the relationship of MC with the body composition variables, gender, and sports participation, a linear regression analysis was performed.

Results

Girls scored higher on the MABC - 2 motor skills test in all age groups (M=10.08, SD=2.16), compared to boys (M=8.90, SD=2.15) (Table 1). The highest mean BMI was in 13-year-old boys (24.86), and they also had the highest mean standard deviation of 6.22. The distribution of BMI was highest in the 13 -year-old age group in both genders. BMI was on average higher in boys than girls at the ages of 13 and 14, but in contrast in the 15-, and 16-year-olds, where it was higher in girls than boys. On average, girls had a higher BF% than boys, the difference was smallest at 13 years of age (24.17 for girls and 21.09 for boys) but considerably higher at 14-16 years of age. Boys had a higher average waist circumference than girls at 13, 14, and 16 years of age, but girls had slightly higher waist circumference at the age of 15 years. There was a statistically significant difference in motor skills between the sexes at 13 years of age (t=-3.35, p <0.05), 14 years of age (t=-2.65, p <0.05), and 15 years of age (t=-2.72, p = 0.05)) where girls were measured with better motor skills compared to boys. At 16 years of age, there was no significant difference in the performance of the motor skills test in girls and boys (t=-1.13, p = 0.24). No significant differences were observed between genders in HGS in ages 13 and 14, but boys showed significantly better handgrip score at age of 15 (29.7 kg for boys and 24.0 kg for girls, respectively) and 16 (34.8 kg for boys and 26.1 kg for girls, respectively).

Figure 1 shows that 60% of girls play sports in a sports club four times a week and 46.7% of the girls in the age

TABLE 1

PARTICIPANT'S MOTOR COMPETENCE SCORE, BODY COMPOSITION, AND HANDGRIP STRENGTH IN RELATION TO GENDER AND AGE

Age (years)	Gender (n)	Standard score MABC -2	BMI	BF%	Waist circumference (cm)	HGS (kg)
13	Boys (45)	8.7 (2.2)	24.9 (6.2)*	21.1 (8.5)	72.5 (9.3)*	21.4 (4.4)
	Girls (45)	10.3 (2.2)*	23.2 (5.9)	24.2 (7.4)*	67.3 (9.7)	20.0 (4.2)
14	Boys (48)	9.2 (2.2)	21.0 (4.3)*	18.1 (8.6)	72.4 (11.3)*	25.6 (5.4)
	Girls (45)	10.3 (2.0)*	20.7 (2.7)	25.9 (5.5)*	67.9 (6.0)	23.9 (3.8)
15	Boys (35)	8.6 (2.3)	21.3 (4.3)	15.5 (8.6)	74.1 (11.8)	29.7 (6.5)*
	Girls (27)	10.1 (1.2)*	22.3 (3.8)*	27.3 (6.8)*	74.8 (11.2)*	24.0 (3.8)
16	Boys (49)	9.0 (1.9)	21.7 (3.7)	14.6 (6.7)	74.8 (8.7)*	34.8 (7.4)*
	Girls (36)	9.6 (2.6)	22.5 (3.1)*	27.4 (5.4)*	71.1 (6.5)	26.1 (4.1)

Values are means (SD). MABC - 2 = higher number reflects better motor competence.
*Significant gender differences (p<0.05).

group of 13 years old. A similar percentage of boys and girls do not play sports in a sports club (22.2% of boys and 17.8% of girls, respectively). In the age group of 14-years old boys and girls, it is a very different situation compared to the previous age group. In total, 54.2% of boys participate in sports activities four or more times a week, compared to 40% of girls. At the same time, 16.7% of boys do not participate in any physical activities, compared to 33.3% of girls. Very similar pattern has been observed in 16-years old group.

Girls showed better fine motor skills and balance at the age of 13-16 years. The gender difference in fine movements was statistically significant at 13, 14, 15, and 16 years of age, and the gender difference in balance is significant at 14 and 15 years of age (Table 2).

Boys were better at aiming and catching at the age of 13-16 years and the difference was statistically significant at age of 15-16.

TABLE 2

PERFORMANCE OF SUB-COMPONENTS OF THE MABC-2 TEST BY GENDER AND STANDARD SCORE

Age (years)	Gender (n)	Fine movements	Aiming and catching	Balance
13	Boys (45)	6.2 (2.7)	10.1 (3.2)	12.0 (2.2)
	Girls (45)	9.0 (2.4)*	9.80(2.8)	12.2 (2.3)
14	Boys (48)	6.4 (2.5)	11.1 (3.0)	11.6 (2.5)
	Girls (45)	8.8 (2.4)*	10.2 (2.8)	12.6 (2.0)*
15	Boys (35)	6.2 (2.7)	10.9 (3.3)*	10.5 (2.7)
	Girls (27)	9.0 (2.4)*	9.1 (3.1)	13.0 (1.7)*
16	Boys (49)	6.1 (2.5)	11.6 (3.0) *	11.6 (2.3)
	Girls (36)	8.2 (2.7)*	9.3 (3.7)	12.5 (2.5)

*Independent t-test for the significant gender difference from boys (p<0.05). Values are means (SD). Fine movement, throw and catch, balance = higher value means a better result.

When all participants were grouped together, a weak significant correlation was found between the performance of the MABC-2 test and the waist circumference (r=-0.196, p<0.05). There was no significant correlation between the performance of the MABC-2 test with BMI or BF% body fat percentage (Table 3). A strong significant positive correlation was found between the body composition variables.

TABLE 3

CORRELATION BETWEEN THE PERFORMANCE OF THE MABC-2 AND BODY COMPOSITION.

	MABC–2	BMI	BF%	Waist circumference
MABC–2	1	-0.1	0.0	-0.2*
BMI		1	0.6*	0.7*
BF %			1	0.5*
Waist circumference				1

*The correlation is significant with 95% of confidence (p<0.05).

Statistically significant correlations were observed between success in MC and body composition in the group of boys 15 years of age (Table 4). Another significant correlation was observed between success in MC and BMI in the group of 15 years old boys. The correlation between MC and BMI, waist circumference and BF% is positive in 14-year-old girls, however, it is not significant based on the 95% confidence interval. There is a trend toward a relationship that is still not significant. The highest correlation between MC and sports participation was measured in 15-year-old boys, the correlation was moderately strong and positive ($r(34) = 0.45$, $p < 0.001$), 15-year-old boys who play sports have higher motor competence.

TABLE 4

CORRELATION OF MC SCORE WITH BODY COMPOSITION AND SPORTS PARTICIPATION BY GENDER AND AGE

Age (years)	Gender (n)	BMI	BF%	Waist circumference	Sports participation
13	Boys (45)	-0.1	-0.2	-0.2	0.2
	Girls (45)	-0.0	0.0	-0.1	0.3
14	Boys (48)	-0.3*	-0.3	-0.2	0.1
	Girls (45)	0.2	0.3	0.2	0.2
15	Boys (35)	-0.4*	-0.4*	-0.4*	0.5*
	Girls (27)	0.0	0.1	0.1	-0.1
16	Boys (49)	-0.1	-0.1	-0.2	0.2
	Girls (36)	-0.1	0.1	-0.1	0.3

*The correlation is significant with 95% of confidence (p<0.05).

TABLE 5

FACTORS INFLUENCING MC EXAMINED BY LINEAR REGRESSION ANALYSIS

	Motor competence			
	ß	t	p	R^2
				0.2
Gender	0.2	2.3	0.0*	
Sports participation	0.2	3.7	0.0**	
BF%	0.1	1.0	0.3	
Waist circumference	-0.2	-2.0	0.1*	
BMI	0.0*	0.3	0.8	

*The correlation is significant with 95% of confidence (p<0.05). ß=beta coefficient, R^2=coefficient of determination.

As shown in Table 5, the strongest factors influencing statistical motor competence were gender (t=2.26, p=0.024), sports participation (t=3.697, p=0.001), and waist circumference (t=-2.000, p=0.046).

A significant positive correlation has been observed among HGS and percentage of fat tissue and waist circumference in 13-years old girls, HGS and BMI in 15-years old girls, HGS and percentage of fat tissues and HGS and MABC-2 test among 16-years old girls (Table 6).

4. Discussion and Conclusion

The aim of this study was to investigate the relationship between motor competence (MC), body composition, handgrip strength (HGS) and sports participation among Icelandic adolescents aged 13-16 years, as well as to identify gender differences. The improved understanding of these relationships has important implications for adolescents' health and well-being, as it sheds light on how body composition and sports participation affect motor competence and, consequently, physical activity and physical fitness. The main finding of this study was that girls showed significantly better MC than boys at ages 13, 14 and 15, with a convergence at age 16. Girls also showed better fine motor skills. In addition, we observed a "U-shaped" pattern of sports participation across age groups in both genders, indicating a decrease in sports participation with increasing age, especially in girls. A

TABLE 6

CORRELATION BETWEEN HANDGRIP STRENGTH (HGS) AND BODY COMPOSITION AND MOTOR COMPETENCE.

		Boys 13	Girls 13	Boys 14	Girls 14	Boys 15	Girls 15	Boys 16	Girls 16
		HGS	HGS	HGS	HGS	HGS	HGS	HGS	HGS
BMI	r	0.2	0.1	-0.0	0.1	0.2	0.3*	0.3*	0.3
	p	0.2	0.3	1.0	0.4	0.1	0.1	0.0	0.1
FAT%	r	-0.1	0.5**	-0.1	0.1	0.1	0.3	0.1	0.4*
	P	0.6	0.0	0.5	0.4	0.5	0.1	0.6	0.0
Waist	r	0.1	0.5**	0.1	0.1	0.2	0.2	0.2	0.2
	p	0.3	0.0	0.5	0.4	0.1	0.3	0.1	0.3
MABC-2	r	0.0	0.0	0.0	0.1	-0.0	0.3	0.1	0.6**
	p	0.7	1.0	0.9	0.2	0.9	0.2	0.7	0.0

*The correlation is significant with 95% of confidence (p<0.05).

notable correlation was found between MC and sports participation in 15-year-old boys. Similar results were reported by Bondi et al; Morillo-Baro et al; Pahlevanian et al; Valtr et al.[25-28], where girls performed better at fine movement tasks than boys. The study explained this to be due to differences in visual perception and use of manual skills between genders, such as housework activities, meal preparation, personal care, cleaning, cutting, nail polishing, and applying make-up. It is known that girls reach puberty earlier than boys and therefore master more complex movements earlier than boys[29]. Boys between the ages of 13-15 are in the fastest growth period and therefore have greater difficulty performing precise movements. Testosterone is responsible for acquiring more muscle mass, greater strength, and stronger and larger bones. It is known that bones and muscles grow very fast at this age in boys (in girls even earlier) and therefore the interaction between nerves and muscles is temporarily disturbed[30]. The current study revealed that the genders are more equal in MC at the age of 16 (no significant difference). At this age, the rate of growth in boys has slowed down. Hormonal changes trigger development in girls at an earlier stage than in boys [31], but boys have faster development once puberty starts. Lombardo and Deaner concluded that the gender divergence in athletic performance begins at the age of 12-13 years and reaches the adult plateau in the late teenage years with the timing and tempo closely parallel to the rise in circulating testosterone in boys during puberty [32].

The findings from this study show that girls have a significantly higher BF%. This is in line with results obtained in other studies that revealed that women had approximately 10% higher body fat compared to men 33] and BMI is higher in boys 13-14 years old but becomes higher in girls when they turn 15-16 because of a higher BF% in girls. Most girls stop growing at the age of 15-16 but gain mass (fat tissue) [34].

Previous study [35] which was conducted on younger age groups than the age group used in the current study, investigated a correlation between MC and BMI and showed no significant correlation. Contrary to the finding of the current study, Lima et al. [16] found that higher body fat was associated with lower MC during childhood. Antunes et al [36] observed an inverse correlation between fat mass and attained levels of gross MC among Portuguese adolescents, and Doloma et al. [37] presented that increased BMI was correlated with a decrease in MC results. Smits-Engelsman et al. [38] concluded that obesity was shown in 9.6% of the children who were classified by the MABC-2 test as normal range and 11.6% of the African children in the at-risk category of the MABC-2 test. They also raised the issue of whether these assessments would be valid since the MABC-2 test was created in Western European countries, and item choice, population norms, and cut-off scores may be limited to those regions and may be influenced by cultural context. Hamilton et al. [39] found that a negative relationship exists between Hispanic low socioeconomic status children's PMDS-2 performance and their BMI. A negative relationship was found between participants' gross motor performance (i.e., object manipulation) and BMI, and their fine motor performance (i.e., visual-motor integration) and BMI. Certainly, cultural and geographical circumstances play an important role.

In the current study, the only statistically significant correlation between MC score and sports participation was found among 15-year-old boys, where 54.3% of boys reported active participation in sports club activities four times or more per week. A possible explanation is that MC can be an important factor in youth participation in sports or youth with very good motor skills are more likely to participate in sports. This should be of concern as with increased age women are more likely than men to fail to meet national guidelines for both aerobic exercise and muscle strength [40].

MC does not develop to its potential naturally; rather it requires instruction and deliberate practice along with feedback in addition to free play. Accordingly, organized sports and physical education appear to be critical for the individual to ensure optimal motor development. A regular PA is essential for the development of MC 7 and engaging in both structured and unstructured PA has been shown to enhance MC and PF. Therefore, the importance of PA and participation in sports need to be stressed. The current study reveals that sports participation decreases dramatically with increased age in both genders, especially in girls. Therefore, it is of concern to strengthen PA and mandatory PE in schools.

It is important that coaches and PE teachers are familiar with the importance of MC in PA. As well as the gender differences in growth, development, and athletic abilities of this age, so the training can be planned and executed in a safe manner that will increase physical performance. General development of some technical aspects of sports and physical abilities should be equal for both genders, but specific exercises must be performed respecting gender differences. An example of a sport where this is taken into consideration is athletics where the mass of the throwing equipment and height of hurdles for girls and boys is different from the age of 12. The difference in hurdle height between boys and girls is intended to provide female athletes with an equal opportunity to compete and perform to the best of their abilities, without being at a disadvantage due to their height or leg length. Boys develop at a faster rate than girls during adolescence, due to the increase in testosterone levels, so those involved in coaching and PE teaching of adolescents must be aware that improvements in performance from pre to end of adolescence, are expected mostly due to growth and maturation. Progress differs for every individual and dramatic change occurs after puberty.

In the present study, results showed that girls have significantly better MC than boys in all age groups except at the age of 16. There was no significant correlation between the performance on the MABC-2 test with BMI or body fat percentage and a weak significant correlation was found between the performance on the MABC-2 test and waist circumference.

Sports participation was the strongest predictor of MC for the whole cohort, furthermore, a significant correlation was observed between MC and sports participation in boys aged 15.

HGS occurs to be somewhat correlated with body composition and MC, not showing a clear pattern through the age groups and genders. Correlations appear to be scattered which could be explained by the turbulent nature of development and maturation of the study age group.

In summary, this study sheds light on the intriguing dynamics of motor competence, gender differences, and the impact of sport participation in adolescents aged 13-16 years. Our findings highlight the need for structured physical education, tailored coaching and targeted interventions to promote motor development. They also highlight the importance of further research that crosses cultural boundaries and explores the longitudinal development of gender differences in motor competence.

It is important to acknowledge that the generalizability of our findings is limited due to the specific geographic focus of the study on Iceland. Future studies should aim to diversify the cultural regions studied to gain a more comprehensive understanding of motor patterns and outcomes. Longitudinal studies may provide deeper insights into the development of gender differences over time. To the best of our knowledge, this is the first study that correlated HGS and MC in adolescents.

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ODNOS IZMEĐU MOTORIČKIH KOMPETENCIJA, SASTAVA TIJELA, JAKOSTI STISKA ŠAKE I BAVLJENJA SPORTOM MEĐU ISLANDSKIM ADOLESCENTIMA

S A Ž E T A K

Motoričke kompetencije mogu utjecati na bavljenje sportu kod djece i mladih. Istraživanja ukazuju na pozitivan utjecaj motiričkih kompetencija na zdrav način života i sprječavanje prekomjerene tjelesne težine. Manje studija bavilo se odnosom između motoričkih kompetencija, tjelesne građe i jakosti tijekom perioda adolescencije. Stoga je cilj ovog istraživanja bio ispitati odnos između motoričkih kompetencija, sastava tijela, jakosti stiska šake (HGS) i bavljenja sportom kod adolescenata u dobi od 13 do 16 godina, kao i ispitati razlike između spolova. Podaci za 177 dječaka i 153 djevojčice prikupljeni su i analizirani. Sastav tijela procjenjivao se putem mjerenja tjelesne visine, tjelesne težine, opsega struka, postotka tjelesne masti (FAT%) i izračunavanjem indeksa tjelesne mase (BMI). Motoričke kompetencije procjenjene su korištenjem testa motoričkog procjenjivanja kretanja (MABC-2), a koji se sastoji od osam zadataka koji mjere ciljanje i hvatanje, ravnotežu i spretnost ruku. Jakost stiska šake ocijenjena je pomoću ručnog dinamometra, a pitanje o sudjelovanju u sportu ispitano je putem upitnika. Rezultati istraživanja pokazuju da djevojčice imaju bolju motoričku kompetenciju u dobi od 13, 14 i 15 godina (djevojčice 13 godina: 10.3, dječaci: 8.7; djevojčice 14 godina: 10.3, dječaci: 9.2; djevojčice 15 godina: 10.1, dječaci: 8.6), ali nije bilo značajne razlike između spolova u dobi od 16 godina (djevojčice: 9.6, dječaci: 9.0). HGS je imao pozitivnu korelaciju sa FAT% ($r=0.5$, $p<0.05$) i opsegom struka kod 13-godišnjih djevojčica ($r=0.5$, $p<0.05$), BMI-om kod dječaka u dobi od 16 godina ($r=0.3$, $p<0.05$), i FAT% ($r=0.4$, $p<0.05$) i MABC-2 kod djevojčica od 16 godina ($r=0.6$, $p<0.05$). Sudjelovanje u organiziranim sportskim aktivnostima bilo je najvažniji faktor u predviđanju motoričke kompentencije kod adolescenata u dobi od 13 do 16 godina ($t=3.7$, $p<0.05$). Buduće studije bi se trebale usmjeriti na istraživanje rodnih razlika u dugogodišnjem trajanju i u tom slučaju longitudinalne studije će osigurati bolje objašnjenje navedenih odnosa .