GROSS MOTOR COORDINATION IN ADOLESCENTS: AN INTER-SPORT ANALYSIS USING THE KÖRPERKOORDINATIONS TEST FÜR KINDER

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Abstract

Background: *The aim of the study was to compare the gross motor skills of adolescent athletes engaged in football, rowing, and wrestling.*

Methods: *A total of 51 adolescent athletes aged 8–14 years (age: 11.82 years, height: 151.86 cm, weight: 48.90 kg, and body mass index (BMI): 20.65 kg/m²) voluntarily participated in the study. The Körperkoordinations Test für Kinder (KTK) was used to assess the participants' gross motor skills.*

Results: *The findings showed that rowing athletes scored significantly higher than wrestlers in total KTK scores (KTK total), as well as in the Walking Backwards (WB) and Jumping Sideways (JS) subtests ($p<0.05$). Football players were found to have higher JS and WB test scores compared to wrestlers ($p<0.05$). Additionally, based on the Hopping for Height (HH) test scores, football players scored significantly higher than rowers, while rowers scored significantly higher than football players in the WB test ($p<0.05$). On the other hand, among the gross motor tests administered, no significant differences were found between the sports branches only in the Moving Sideways (MS) test scores ($p>0.05$).*

Conclusions: *These results indicate that different sports branches develop balance and coordination components at varying levels, underscoring the importance for coaches to design supportive training*

programs that target weaker motor skills while preserving branch-specific strengths. Accordingly, educators and coaches should enrich training programs — particularly with complementary exercises involving balance, jumping, and coordination — by taking inter-branch differences into account to better support athletes' motor development.

Keywords: gross motor skills, sports disciplines, coordination, motor development.

1. INTRODUCTION

Sport is a means that enables individuals to develop physically, mentally, emotionally, and socially, while also enhancing knowledge, skills, and leadership abilities (Ekici et al., 2011). Whether performed individually or as a team, sports not only help individuals reveal their personal abilities but also play an important role in socialization (Kılıç & Arslan, 2018). One of the periods in which sport has the greatest impact on human development is childhood (Çelik & Şahin, 2013). Sports involving movement also support motor skills; thus, when children engage in sports, both their motor and social abilities are enhanced (Yıldız & Çetin, 2018). Motor development is essential for the body to function optimally starting from childhood (Yılmaz et al., 2024). Moreover, motor development is critically important for a child to interact with the environment, explore the world, and develop motor skill components such as balance, coordination, and agility (Çelikel & Sezer, 2024).

Motor skills are defined as movements or groups of movements performed as a result of learning through experience (İbiş et al., 2021). These skills support children in fulfilling their social and emotional tasks and contribute to a healthy start to a high-quality life (Canlı, 2024). Motor development is influenced not only by environmental factors but also by components such as attention, strength, balance, reaction time, speed, endurance, flexibility, and coordination. Additionally, coordination — one of the elements of motor fitness — is an important component for motor development.

Coordination in sports is defined as the ability to perform different movements in a purposeful and harmonious manner, in other words, the coordinated functioning of skeletal muscles and the central nervous system during a goal-directed action (Yılmaz et al., 2024). The literature emphasizes that starting coordination training at an early age increases technical proficiency, enhances the rate of learning, and strengthens adherence

to sport (Lubans et al., 2010). Furthermore, coordination contributes not only to physical performance but also to cognitive functions. Significant relationships have been reported between coordination and higher-order cognitive processes such as attention, memory, decision-making, and problem-solving (Memmedova, 2022). Although the human brain can adapt to certain stress-induced changes, stress remains a critical factor with substantial effects on the nervous system. At this point, exercise can alleviate the negative effects of stress due to its multifaceted contributions to cognitive functions, particularly demonstrating dynamic and supportive effects on memory functions (Loprinzi et al., 2019).

Each sports branch has its own unique skill characteristics and consists of movements that involve complex activities. For this reason, the coordination abilities required by different sports may vary (Singh, 2004). Wrestling is a sport that involves intermittent loads, requiring high levels of muscular strength and power in both the upper and lower extremities, as well as a well-developed anaerobic energy metabolism (Kraemer et al., 2001). In football, it is important to develop sports skills that require technical and tactical qualities; factors such as muscle strength, maximal movement speed, and neuromuscular activation are also essential for optimal performance (Zhidong et al., 2021). In rowing, there are single, double, four-person, and eight-person boat classes with or without a coxswain, categorized as Olympic single- and double-oar events. Except for the single scull, all boat classes require team coordination. In these boats, synchronization and coordination among teammates, who must perform rowing techniques simultaneously, are crucial elements for winning races (Kleshnev, 2015). Therefore, an athlete becomes successful when their skill abilities align with the demands of the sport they engage in (Koç, 2006).

In light of this information, identifying motor skills that match the characteristic requirements of different sports is critical in guiding athletes and supporting appropriate branch selection. However, the literature on monitoring and comparing motor development processes among athletes participating in wrestling, football, and rowing is quite limited. In this context, the aim of the present study was to compare the gross motor skills of adolescent athletes engaged in football, rowing, and wrestling. The study

hypothesized that the gross motor skill development levels of children participating in different sports branches would differ from one another.

2. METHODS

The study was designed in accordance with the relational screening model. The athletes visited the laboratory twice for the measurements. During the first visit, the participants were shown sample applications of the Körperkoordinationstest für Kinder (KTK), and anthropometric measurements (height and body weight) were taken. Before the tests, a 10-minute warm-up protocol (mobilization and stretching) was applied. All measurements were conducted at the same time of day (14:00–16:00) and under similar environmental conditions (temperature between 19–22 °C and humidity between 52–60%). An Informed Parental Consent Form was obtained from the families of individuals who volunteered to participate in the study, and children whose parents did not provide consent were excluded.

The study was carried out in accordance with the ethical principles stated in the Declaration of Helsinki. Ethical approval was obtained from the Sinop University Human Research Ethics Committee (Protocol No: 209/310 – Date: 09-05-2025).

Participants

The sample of the study consisted of 51 athletes aged 8–14 years who actively participated in wrestling, rowing, or football in the province of Sinop. The inclusion criteria were: actively engaging in sports, having at least three years of training experience in rowing, football, or wrestling, and having no significant injury history within the past six months. Volunteers who did not meet the inclusion criteria were excluded from the study. Descriptive characteristics of the participants are presented in Table 1.

Table 1. Descriptive characteristics of the participants (n = 51)

	Mean	SD	Min.	Max.
Age (year)	11.82	1.83	8.00	14.00
Height (cm)	151.86	13.59	128	180
Weight (kg)	48.90	16.72	27.00	98.00
BMI (kg/m²)	20.66	4.29	14.27	33.20
Sport Branch	Frequency		Percent	
Wrestling	16		31.4	
Rowing	21		41.2	
Football	14		27.5	

SD: Standard Deviation; Min: Minimum; Max: Maximum

Procedures

Anthropometric Measurements

Height and weight measurements of the participants were performed using SECA 804 and SECA 213 devices (Hamburg, Germany). Height was measured with the children standing barefoot, feet together, and with their back, buttocks, and heels in contact with a vertical wall, ensuring an upright posture; the distance from the top of the head to the floor was recorded (Lohman et al., 1988). Weight measurements were taken while the children were lightly dressed and barefoot. For all participants, body mass index (BMI) was calculated using the formula: weight/height² (kg/m²).

Körperkoordinations Test für Kinder (KTK)

The Kiphard and Schilling Children's Body Coordination Test (KTK: Körperkoordinations Test für Kinder) was developed by Kiphard and Schilling (1974) and modernized in 2007. Known in the literature as "KTK," this test is designed to assess coordination and movement proficiency in children aged 5–14 years (Kiphard & Schilling, 2007). The KTK is also used in research aiming to evaluate children's general psychomotor, social, psychological, and healthy lifestyle levels, in addition to motor coordination.

The motor coordination test for children is considered highly reliable (r = 0.85) and valid (r = 0.60–0.80) for evaluating motor skills (Kiphard & Schilling, 2000; Lvonen, Saakslahti, & Laukkanen, 2016). It consists of four physical subtests: Walking Backwards (WB), Hopping for Height (HH), Jumping Sideways (JS), and Moving Sideways (MS), with an average administration time of approximately 15 minutes per child.

The test evaluation categorizes children's motor coordination as follows: "insufficient motor coordination" (MK < 56), "severe motor inadequacy" (MK 56–70), "moderate motor inadequacy" (MK 71–85), "normal" (MK 86–115), "good" (MK 116–130), and "very good" (MK 131–145+). The overall motor coordination score is

determined by calculating the mean of the raw scores obtained from the subtests and considering age and gender.

Walking backwards (WB)

The balance station consists of three wooden beams with a height of 3 cm and a total length of 3 m, with widths of 6 cm, 4.5 cm, and 3 cm, respectively. The distance between adjacent beams is 50 cm. During the test, the participant walks backwards along the three parallel beams, starting from the widest to the narrowest. The total score is obtained by summing the scores from three consecutive attempts on each beam. This score represents the first motor skill coefficient. Each attempt can earn a maximum of 8 points, yielding 24 points per beam and a maximum of 72 points for the entire test. Each backward step without touching the ground scores 1 point, while the first step is not counted (Livonen et al., 2016).

Hopping for height (HH)

The obstacles are soft, with dimensions of 5 cm in height, 20 cm in width, and 50 cm in length. Immediately before the jump, the participant approaches the obstacle by hopping once or twice on one foot, then jumps over the obstacle using the same foot. Starting heights are as follows: ages 5–6: 5 cm; ages 7–8: 15 cm; ages 9–10: 25 cm; ages 11–14: 35 cm. If the participant fails on the first attempt but succeeds on the second, 2 points are awarded; if successful on the third attempt, 1 point is awarded, and the participant proceeds to the next level. Failure on the third attempt terminates the test. Each foot can score a maximum of 39 points, allowing for a combined maximum score of 78 points with both feet (Özkara & Kalkavan, 2018).

Jumping Sideways (JS)

This test uses a wooden beam (height: 2 cm, length: 60 cm, width: 4 cm) that can be marked to define the test area if necessary. The test is time-limited. Each successful jump is awarded 1 point. Participants jump laterally to the left or right for 15 seconds, and each successful jump is counted individually. The total score at the end of the time period is recorded, and a second trial is performed. The sum of the points from both trials is taken as the final score (Özkara & Kalkavan, 2018).

Moving Sideways (MS)

The test uses two square wooden platforms, each 25 cm in length and width and 2 cm in height, supported underneath by four fixed legs (height: 3.7 cm) to stabilize the platforms on the ground. The participant starts by standing on the first platform with both feet, bends down, moves the other platform sideways using both hands, and steps onto it. The participant must hold the platform with both hands and stand on it with both feet. The test is time-limited, and two trials are performed. One point is awarded for each platform successfully moved and crossed. The total score within 20 seconds is recorded, and the second trial is conducted. The final score is the sum of the scores from both trials (Bardid et al., 2015).

Data Analysis

The data were analyzed using the SPSS 23.0 statistical software package. The normality assumption of the obtained data was evaluated using the Kolmogorov-Smirnov test ($p > 0.05$), and the data were found to be normally distributed. Variables are presented as mean ± standard deviation and frequency values. One-way ANOVA was used to compare the KTK scores of the participants, and Tukey's post-hoc test was applied to determine which groups showed significant differences. Effect sizes for paired group comparisons were calculated using Cohen's d formula: $(M_2 - M_1)/SD_{pooled}$. According to this formula, $d < 0.2$ indicates a small effect size, $d = 0.5$ indicates a medium effect size, and $d > 0.8$ indicates a large effect size. Statistical significance was set at $p < 0.05$ for all tests.

3. RESULTS

Table 2. Comparison of KTK test results across sports branches

ANOVA	Sports	Mean	SD	F	p	Tukey (p, ES)
WB	Wrestling [a]	51.31	11.99	8.852	<0.001*	a<b (p=0.039; 0.82) c<b (p<0.000, 1.47)
	Rowing [b]	60.67	10.75			
	Football [c]	44.86	10.73			
HH	Wrestling [a]	71.88	5.19	7.945	<0.001*	b<c (p=0.001; 1.37)
	Rowing [b]	68.00	8.72			
	Football [c]	77.00	3.21			
JS	Wrestling [a]	30.19	6.06	30.136	<0.000*	a<b (p<0.000; 1.83)

	Rowing [b]	40.33	4.96			a<c (p<0.000, 2.63)
	Football [c]	44.21	4.49			
MS	Wrestling [a]	19.81	4.23			
	Rowing [b]	23.10	4.55	2.826	<0.069	---
	Football [c]	20.93	3.89			
KTK Total	Wrestling [a]	173.81	21.45			
	Rowing [b]	192.57	18.80	4.418	<0.017*	a<b (p=0.014; 0.93)
	Football [c]	187.00	16.98			

SD: Standard Deviation; ES: Cohen effect size; WB: Walking backwards; HH: Hopping for height; JS: Jumping Sideways; MS: Moving Sideways, KTK Total: Total KTK Score

Table 2 presents the comparison of KTK test results across sports branches (ANOVA). The results indicated that rowers scored significantly higher than wrestlers in KTK Total (p= 0.014; ES= 0.93) as well as in WB (p=0.039; ES: 0.82) and JS (p<0.000; ES=1.93). Football players also performed better than wrestlers in JS (p<0.000; ES:2.63). Furthermore, in HH, football players scored higher than rowers (p=0.001; ES:1.37), whereas in WB, rowers scored significantly higher than football players (p<0.000; ES:1.47). No significant differences were observed between sports branches in MS (p>0.05).

4. DISCUSSION

The present study, designed according to a relational screening model, aimed to compare the gross motor skills of adolescent athletes participating in different sports branches (rowing, wrestling, football). Several major findings were identified. From the KTK subtests, rowers demonstrated significantly better gross motor skill scores in WB compared to football and wrestling athletes. In addition, football players showed superior performance in HH, while both football and rowing athletes outperformed wrestlers in JS. No significant differences were observed between branches in MS, whereas rowers achieved significantly higher scores than wrestlers in KTK Total.

Recent studies on motor coordination and motor competence indicate that the sport practiced (team *vs* individual) affects the motor skill profiles of individuals. One study reported significant differences in motor coordination (such as balance, jumping, and lateral movement) among children participating in different sports or activity levels, with children engaged in sports performing better than their non-active peers (Canli et

al., 2023; Stanković et al., 2023). The results of the present study, which demonstrate significant differences in gross motor skills among athletes from different sports branches, are consistent with the literature.

The WB test results showed that rowers performed significantly better than football and wrestling athletes. This finding can be attributed to the rhythmic nature of rowing, which requires a high level of neuromuscular coordination, particularly enhancing lower-extremity synchrony. Although balance and coordination are also important in wrestling and football, movements in these sports are more variable and context-dependent, making superior performance by rowers in this test an expected outcome (Baudouin & Hawkins, 2004). Previous research suggests that the high degree of rhythmic integration, postural stabilization, and coordinated upper- and lower-extremity movements in rowing may lead to superior balance and coordination compared to athletes in other sports (McNeely, 2005).

The HH test results indicated that football players exhibited superior gross motor skills compared to rowers. This may be related to the higher demands for rapid responses, quick directional changes, and spatial-temporal timing in football. Research has shown that lower-extremity neuromuscular control, stability, and core strength are strongly associated with football-specific skills and performance (Asan et al., 2025). Similarly, Vandendriessche et al. (2012) emphasized that football, as a team sport requiring high levels of agility, reaction speed, and explosive power, contributes to the enhanced development of speed, agility, and jumping abilities in football players compared to athletes in other branches.

Furthermore, JS test results demonstrated that both football and rowing athletes performed significantly better than wrestlers. This finding suggests that rowers benefit from repeated execution of coordinated motor skills with high technical precision, while football players' superior performance may stem from the need for rapid decision-making and immediate execution in a constantly changing game environment. In contrast, no significant differences were observed between branches in the MS test. This result indicates that this test assesses a more general coordination component and is less influenced by sport-specific technical skills. Similarly, a study involving 478 children aged 7–9 reported that this test primarily evaluates general motor skills such as upper-

and lower-extremity flexibility, balance, laterality (left-right), and basic coordination, rather than sport-specific techniques like rowing, wrestling moves, or football ball control (Nopembri et al., 2024). Studies conducted with athletes from different sports have also reported that general motor skills are important and need to be developed from an early age (Ölmez et al., 2022; Şar & Akgün, 2025; Akgün, 2023).

When comparing KTK Total scores across branches, rowers scored significantly higher than wrestlers but did not differ significantly from football players. This suggests that rowers' training routines, postural control, rhythmic coordination, and upper- and lower-extremity balance may provide an advantage over wrestlers in developing general motor skills. Additionally, although rowing and football athletes outperformed each other in certain subtests, the absence of significant differences in KTK Total scores may reflect that both sports involve frequent use of movements requiring overall muscle strength, core stabilization, and coordination (Penichet-Tomas et al., 2023; Rodríguez et al., 2025). On the other hand, wrestlers' lower KTK scores do not imply that wrestling limits the development of coordination skills. Rather, this may be explained by the fact that the specific skill set required in wrestling does not directly correspond to general gross motor coordination and fundamental motor competence tests such as the KTK.

Limitations

When compared with the literature, the present study has several strengths; however, some limitations should be acknowledged. First, the differences in age range and training experience/duration among participants across sports branches may have influenced the results. Second, since the current training programs of the athletes were not known, the observed outcomes may reflect the content of training rather than the inherent nature of the sport. Finally, the relatively small sample size may limit cross-branch comparisons and the generalizability of the findings. Future studies with larger and more homogeneous sample groups, including detailed information on athletes' training programs, may provide deeper and more comprehensive insights.

5. CONCLUSION

The results of the present study indicate that rowers demonstrated the highest overall coordination performance, while football players exhibited marked superiority in HH and JS tests, likely due to the dynamic and reaction-focused nature of the sport. Wrestlers showed lower performance in certain coordination components compared to rowers and football players, which may be attributed to the sport's greater emphasis on strength, combat, and power. These findings suggest that coordination skills are shaped according to sport-specific demands and technical requirements. Furthermore, the results highlight the importance of designing training programs that enhance coordination capacity and are supported by sport-specific elements.

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