ORIGINAL ARTICLE

Motor competence of children with different levels of physical activity

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Abstract

Adequate development, testing, continuous motor competence monitoring and physical fitness are very important factors in the development of children aged 7 to 10. The purpose of this study was to determine the differences in the motor competence of the children engaged in organized physical activities in sports clubs and the children who were not included in any kind of organized physical activity. The study included 119 children, 57 children engaged in organized activities in sports clubs (age: 8.44 ± 0.78; height: 133.17 ± 7.21; weight: 31.96 ± 7.73 BMI: 17.9 ± 3.38) and 62 children who had no additional organized physical activity (age: 8.43 ± 0.84; height: 134.85 ± 7.60; Weight: 34.44 ± 9.20 BMI: 18.7 ± 3.68). Motor competence was assessed by the Kiphard-Schilling body coordination test (KTK). After adjusting for age, gender, and BMI effects, we found small to medium significant mean differences ($p<0.05$, d [95%CI]) between the groups in hopping for height tests (d=0.78 [0.41, 1.16]), jumping sideways (d=0.79 [0.42, 1.17]), moving sideways (d=0.68 [0.32, 1.06]), and walking backward (d=0.44 [0.07, 0.81]). The results have shown that the children who were engaged in organized physical activities in sports clubs have a higher level of motor competence than their peers who were not included in the organized system in sports clubs. The authors strongly suggest that teachers, educators, coaches, and parents should encourage and include children in organized systems of physical activity, i.e., training processes in sports clubs.

Keywords motor competence • children • health • physical activity.

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Introduction

A low level of motor abilities in children, due to reduced levels of physical activity and fitness, has a very negative effect on their health. This phenomenon is very common and is found in children around the world (Moreira et al., 2019). Increasing the level of physical activity directly affects the development of motor competence in children (Stodden et al., 2008). Children who have a high degree of motor skills have a higher share in physical activity (Haga et al., 2008; Lubans, et al., 2010; Wrotniak et al., 2006). It is very important to encourage the development of motor skills from early childhood (Hoeboer, et al., 2016).

Motor competence indicates that the level of performance in various motor skills is very important in children for developing a healthy and active lifestyle (Cattuzzo, et al., 2016). If a child has motor problems and does not solve them during childhood, there might be a higher chance that these problems will be transferred to adulthood (Losse, et al., 1991). Low levels of motor skills can result in behavioral issues and lead to emotional and social difficulties (Mandich et al., 2003). A decreased level of motor skills negatively affects the quality of activities in team sports and, in general, the aspiration to engage in physical activity (Smyth & Anderson, 2000). Quality and adequate programs can significantly influence the development of motor skills and improve the quality of movement (Mačak, et al.,

2021; Popović et al., 2020; Ruiz-Perez et al., 2018).

Most children should naturally enjoy physical activities such as rolling, running, throwing, walking, jumping, etc. There are an increasing number of health problems due to a sedentary lifestyle, and such children are more susceptible to low self-esteem, motivation, and poor social competence (Bar-Or, 2005; Kalverboer et al., 1990) and very often feel unhappy (Schoemaker et al., 1994).

Numerous studies have shown higher level of coordination of the children who are training for some sports and those who are not engaged in some organized form of physical activity. A group of authors (Šalaj et al., 2016) states that multisport programs can be recommended as the best type of exercise for preschool children with certain advantages over specific rhythmic gymnastics and football programs. Another group of authors confirmed that intensive sport-specific training may extend young athletes' motor coordination characteristics in the ability areas depending on the sport in which they engage (Jaakkola et al., 2017). The main results of the study (Popović et al., 2020) have proved that children enrolled in a multicomponent sports activity have a significantly higher level of motor coordination than children enrolled in football. Therefore, they advise and encourage parents, coaches and educators to practice multisports exercise programs as the best physical activity for preschool and younger school-age children. Fransen et al. (2012) indicated the importance of setting aside time for the realization of various physical activities in various sports so that children can develop their gross motor coordination.

In addition to the already established intervention strategies, it is very important to use appropriate measuring instruments. The Körperkoordinationstest für kinder (KTK) is a reliable and inexpensive engine motor coordination test that is already widely used in the world. The KTK was developed in Germany for testing children and adolescents ages 5 to 14 years (Kiphard & Schilling, 2007). The KTK (Körperkoordinationstest für Kinder) contains four tasks: walking backward (VB), hopping for height (HH), jumping sideways (JS), and moving sideways (MS).

The study of Lopes et al. (2012) confirmed that motor coordination demonstrated an inverse relationship with BMI across childhood and into early adolescence. Stodden et al. (2008) claimed that the level of gross motor skills plays a crucial role in starting and sustaining physical activity and physical fitness during adolescence and adulthood as a whole, which is very important in a continuous struggle against obesity and increasing numbers of chronic heart diseases.

The systematic review of Barnett et al. (2022) confirms strong positive evidence for the fitness-mediating motor competence/physical activity pathway in both directions, as well as strong positive evidence for the path from motor competence to health-related fitness and indeterminate evidence from fitness to motor competence. Likewise, there was strong evidence of a positive path from locomotor/coordination skills to fitness in both directions.

In other systematic review (Barnett et al., 2016), authors recognized that physical activity is a positive correlate of skill composite and motor coordination. They also found indeterminate evidence for physical activity being a correlate of object control or locomotor skill competence.

The purpose of this research was to determine whether school-age children's motor competence differentiates between those engaged in organized physical activity and those nonengaged.

Method

Participants

This cross-sectional study included 119 children in two gender-balanced groups, 57 children engaged in organized activities in sports clubs (the physically active group, age: 8.44 ± 0.78; height: 133.17 ± 7.21; weight: 31.96 ± 7.73; BMI: 17.9 ± 3.38) and 62 children who had no organized physical activity (the physically inactive group age: 8.43 ± 0.84; height: 134.85 ± 7.60; Weight: 34.44 ± 9.20 BMI: 18.7 ± 3.68) (Table 1). The physically active children were training for: football (15), volleyball (12), basketball (11), athletics (8), and other sports (11). All participants were students attending two elementary schools in the municipality of Odžaci (Elementary School "Miroslav Antić" and Elementary School "Branko Radičević"). The flow of participants through the research is presented in Figure 1 below. measure.

Table 1. Sample characteristics

Characteristic	Physically active	Physically inactive
Age (years)	8.44 ± 0.78	8.43 ± 0.84
Gender (boys/girls)	30/27	28/34
Body height (cm)	133.17 ± 7.21	134.85 ± 7.60
Body mass (kg)	31.96 ± 7.73	34.44 ± 9.20
BMI (kg/m^2)	17.9 ± 3.38	18.7 ± 3.68

Note: values are presented as mean ± SD; BMI: body mass index.

Inclusion criteria were (1) healthy children, (2) aged 7 to 10, and (3) both gender; and for children in the physically active group (4) exercise in sports clubs for at least one year, (5) a minimum of 60-minute training sessions, (6) exercise two or more days per week, and (7) participate in more than 80% of sessions during the year. Additionally, the inclusion criteria for children in the physically inactive group was (4) not involved in any organized sport or activity. Exclusion criteria were (1) any musculoskeletal and/or neurological disorders, (2) preschool children (< 7 years old), and (3) older children (> 10 years old).

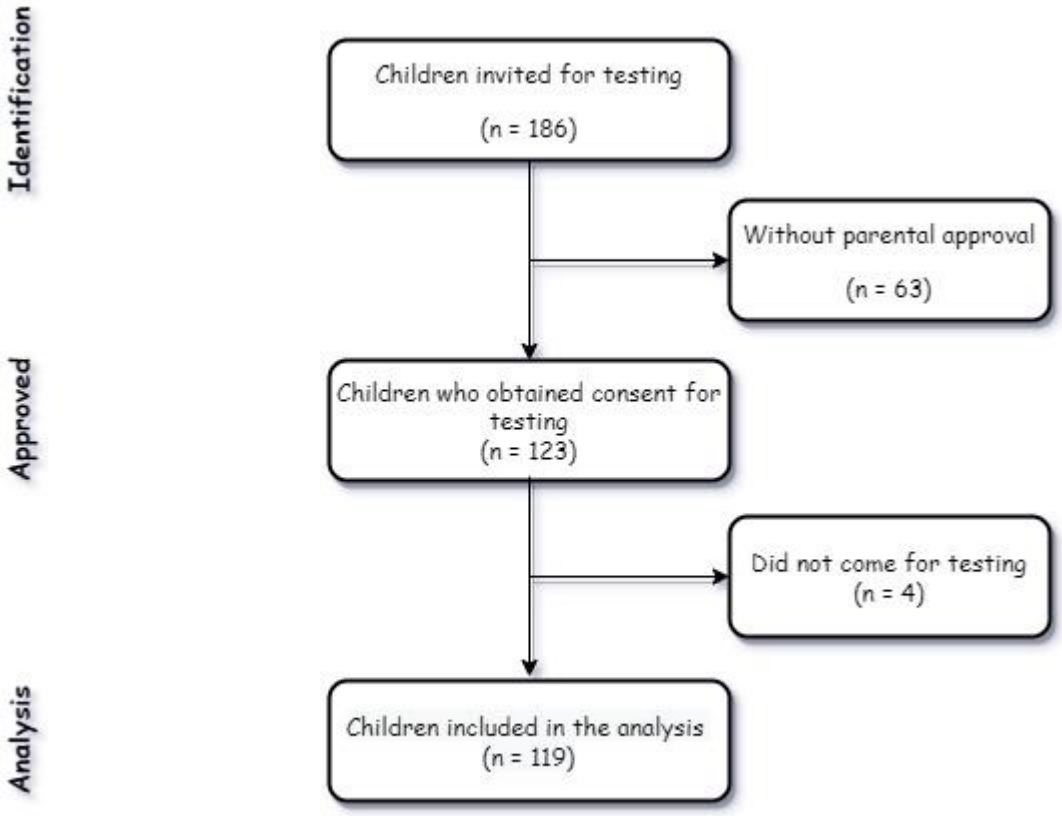

Figure 1. Questionnaire structure PRISMA flow diagram (Moher et al., 2009)

Testing procedures

Body weight was measured with a digital scale (BC1000, Tanita, Japan; ± 0.1 kg), following the guidelines proposed by the International Biological Program (IBP). Body height was measured with a portable stadiometer (SECA 213, respectively, SECA Corp., Hamburg, Germany).

In this study, the Koperkoodination test for children (KTK) was used because it is a reliable and inexpensive engine motor competence test that is already widely used worldwide. The KTK was developed in Germany to test children and adolescents aged 5 to 14 (Kiphard & Schilling, 2007). The KTK consists of four subtests: (1) walking backward (WB) three times across each of three

balance beams (3 m length; 6, 4.5, and 3 cm width, respectively). A maximum of 24 steps (eight per trial) were counted for each balance beam, which comprised a maximum of 72 steps/points (24 steps, 3 beams) for this test; (2) moving sideways (MS) across the floor in 20 sec by stepping from one plate (25 × 25 × 2 cm supported on four legs 3.7 cm high) to the next, transferring to the first plate, stepping on it, and so on. The number of relocations was counted and summed over two trials; (3) hopping for height (HH) on one foot over a foam obstacle and increasing height in consecutive increments of 5 cm. A total of 3, 2, or 1 point were awarded for successful performance on the first, second, or third trials, respectively. A maximum of 39 points (ground level + 12 pillows) could be scored for each leg, yielding a possible maximum score of 78; (4) jumping sideways (JS) as fast as possible over a wooden slat (60 × 4 × 2 cm) in 15 sec. The number of jumps over two trials was summed up. According to the raw scores of these four subtests, an age- and sex-specific percentile rank was calculated using the normative data of 1228 normally developing German children (Kiphard & Schilling, 2007). Although the raw scores for each test are commonly transformed using the sex- and age-specific tables derived from the original German sample to improve the comparability independent of age and sex or to convert to an overall motor quotient. The raw score for each test was retained for the analysis in the current study.

Statistical analysis

The data are expressed as means±SEM unless otherwise stated. The assumption of normality and homogeneity of variances were verified using the Kolmogorov–Smirnov and Leven's test, respectively. The model of motor competence in the function of the group (organized physical activity) was adjusted for gender, age, and BMI effects. Therefore, the organized physical activity effect on motor competence was estimated by the mean differences between the groups of children who had been physically active, and those who had been physically inactive using a one-way ANCOVA (one model of each test). Cohen's d with 95% Confidence Intervals (CI) is calculated as a measure of the standardized mean differences between the groups of physically active and inactive children and interpreted as 0.20 small, 0.50 medium, and 0.80 large (Lakens, 2013). The level of significance was set at $p < 0.05$. All statistical analyses were performed in SPSS statistical software (SPSS 23.0, IBMInc., Chicago, IL, USA).

Results

Table 2 presents detailed information on the results of the analysis. After controlling the effects of age, gender, and BMI in the model, the one-way ANCOVAs showed that the group of children who were involved in organized exercises in a sports club (physically inactive) had significantly better results in all motor competence tests compared to the group of children who were free of organized exercise (physically inactive).

The physically active children had significantly higher results as compared to their physically inactive peers. Small to medium differences (d [95% CI]) were found between the groups for hopping for height tests (d=0.78 [0.41, 1.16]), jumping sideways (d=0.79 [0.42, 1.17]), moving sideways (d=0.68 [0.32, 1.06]), and walking backward (d=0.44 [0.07, 0.81]). Figure 2 illustrates the effect sizes (Cohen's d) with 95% CI for mean differences in each measure.

Table 2. Results of motor coordination tests in physically active and inactive children

Motor coordination tests	Physically active	Physically inactive	ANCOVA			
			Group $F_{(1, 114)}$	Age $F_{(1, 114)}$	Gender $F_{(1, 114)}$	BMI $F_{(1, 114)}$
Walking backward	29.58 ± 1.52	23.24 ± 1.46	8.97**	8.87**	10.04**	7.49**
Hopping for height	41.52 ± 1.56	30.73 ± 1.49	20.35**	24.74**	1.29	20.15**
Jumping sideways	56.59 ± 1.59	46.31 ± 1.52	22.46**	33.69**	0.10	0.03
Moving sideways	42.48 ± 0.83	37.88 ± 0.79	15.93**	22.55**	2.43	2.59

Note: Values are (raw scores) adjusted mean±SEM for covariates appearing in the model evaluated at the following values: age=8.43, BMI=18.34; BMI body mass index; * significant at $p < 0.05$; ** significant at $p < 0.01$.

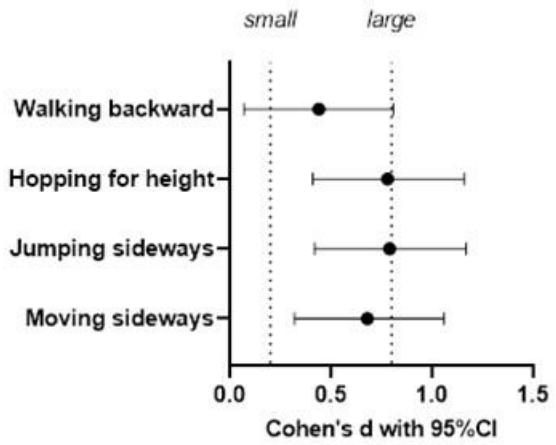

Figure 2. Standardized mean differences and 95% confidence intervals (Cohen's d ± 95% CI) between the groups of physically active and inactive children in motor competence.

Discussion

Based on the KTK protocol developed by Kiphard and Schilling (Kiphard & Schilling, 1974; 2007), the present study aimed to determine the motor competence of young school children aged 7 to 10 involved in organized training processes (in various sports clubs) and the children not included in any kind of organized exercise programs and assess the differences between the groups. The main results of this study show that, on average, after averaging age, gender, and BMI over the groups, the children involved in organized training processes have higher levels of motor competence to a larger extent than their peers.

The KTK assesses fundamental motor skills through four subtests, i.e., walking backward, jumping sideways, moving sideways, and hopping for height (Kiphard & Schilling, 1974; 2007), and such batteries have become widely used to measure motor competence in young athletes, as twelve articles emerged from 2010 to 2014 and twenty-one post-2015 in PubMed (O'Brien-Smith et al., 2019). Our results showed on average significantly ($p < 0.05$) better performance of physically active children to a medium effect on tests hopping for height ($d = 0.78$), jumping sideways ($d = 0.79$), and moving sideways ($d = 0.68$), and to a small effect on walking backward ($d = 0.44$) as compared to physically inactive children. Significantly better results in motor coordination tests in the physically active group of children showed their exposure to a multilateral environment, which has been assumed to be important for acquiring new skills and improving children's motor competence (Popović et al., 2020).

Similar results were found in previous studies. Popović et al. (2020) did research with children aged 7.60 ± 0.85, to determine the differences in motor competence of children enrolled in soccer and multisport activities. The results indicated a large effect size between groups in all motor competence tests, except in walking backward, where small differences were observed; for tests hopping for height ($d = 0.93$), total motor quotient ($d = 1.31$), jumping sideways ($d = 1.32$), and moving sideways ($d = 1.59$), which is related to the results of this study. Children's participation in organized physical activities in addition to regular physical activities at school greatly contributes to the development of motor competence (Haga, et al., 2008; Lubans et al., 2010; Stodden, et al., 2008; Vrotniak, et al., 2006). The result of our research also indicates that additional, organized, and adequately planned and programmed physical exercises achieve significant results in the field of development of motor competence in children ages 7 to 10 years. The results of this study are in line with the outcome of several other cross-sectional studies, clearly demonstrating that children's motor competence is strongly related to the degree of children's physical activity, measured by their participation in organized sports (Bouffard et al., 1996; Cairney, et al., 2005; Popović et al., 2020; Šalaj et al., 2016; Wrotniak, et al., 2006).

In addition to the technical and tactical work related to a particular sport, the organized training process in sports clubs for children ages 7 to 10 mainly consisted of various exercises, games, and polygons, adapted for that age, through which children were exposed to complex forms of movement. By performing a variety of motor tasks that are assigned to them, children improve their motor competence, developing locomotor and object control skills (Popović et al., 2020).

The relatively small sample size and research design can be considered a limitation of the current study, as well as no measurement of habitual physical activity. Moreover, even though we controlled differences in motor competence for age, gender, and BMI effects, the effects of these factors should be further analyzed. Future research could address this topic to determine in more detail how and to what extent certain sports affect the development of motor skills while utilizing experimental research design.

Conclusion

Based on the results of this study, the conclusion drawn is that the children who were included in the training process in sports clubs have a higher level of motor coordination than the children who were not engaged in some kind of organized physical exercise. The results also suggest that the participation of children in organized physical activities (training in sports clubs) can be useful in developing their motor coordination in children aged 7 to 10 years. The authors strongly suggest that teachers, educators, coaches, and parents should encourage and include children in organized systems of physical activity, such as organized training programs in sports clubs.

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