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THE EFFECTS OF AN 8-WEEK BALL GAME INTERVENTION ON THE MOTOR ABILITIES OF 6-7-YEAR-OLDS

VPLIV 8-TEDENSKE INTERVENCIJE IGER Z ŽOGO NA GIBALNE SPOSOBNOSTI 6-7 LETNIKOV

ABSTRACT

In the early childhood stages of development, ball games prove to be a crucial catalyst for improving motor abilities by actively engaging children in various physical movements that promote improved coordination, balance, and spatial awareness, while supporting important social interactions and cognitive skills essential for comprehensive growth. This study examines the effects of an 8-week ball game intervention program (tennis, football, basketball etc.) on the motor abilities of 6- to 7-year-old children (n = 47) in their regular physical education classes. The experimental group (n = 24) participated in 45-minute sessions twice weekly, while the control group (n = 23) received no additional organized physical activities. The hypotheses underlying the study suggest that the experimental group participating in the 45-minute sessions of the structured ball game program twice a week will show statistically significant improvements in these motor abilities compared to the control group.Motor abilities were assessed using the BOT-2 subtests for fine motor integration, manual dexterity, balance, and bilateral coordination and were assessed both before and after the intervention period in both groups. The BOT-2 subtests are standardized measures developed to comprehensively assess specific motor abilities. They were selected for their proven reliability and validity in assessing the motor abilities affected by the intervention and provide a solid basis for the outcome analysis of the study. Data was subjected to repeated-measures ANOVA analysis using a 2×2 design, with partial eta squared (η) used to assess the difference between the EXP and CON groups. Results showed remarkable improvements in fine motor integration (p = 0.016), general fine motor skills (0.021), bilateral coordination (0.004), balance (0.000), and body coordination (0.000) among participants in the intervention group. This study highlights the transformative potential of just two additional weekly sessions of various ball games to improve motor abilities in 6- to 7-year-olds.

Keywords: physical activity, motor skills, children, physical development

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IZVLEČEK

V zgodnjem otroštvu se igre z žogami kažejo kot pomemben dejavnik za izboljšanje gibalnih sposobnosti, saj otroci aktivno sodelujejo v gibalnih/športnih aktivnostih, ki razvijajo koordinacijo, ravnotežje, orientacijo v prostoru, pomembne socialne interakcije in kognitivne spretnosti, ki so pomembne za celosten razvoj otroka. Z izvedeno raziskavo smo v dopoldanskem času med rednimi učnimi urami predmeta šport preverjali učinke 8-tedenskega programa intervencije iger z žogami (tenis, nogomet, košarka idr.) na gibalne sposobnosti otrok, starih od 6 do 7 let (n = 47). Eksperimentalna skupina (n = 24) je poleg rednega pouka sodelovala še v 45-minutnih učnih urah dvakrat tedensko, medtem ko kontrolna skupina ni bila deležna nikakršnih dodatnih organiziranih gibalnih/športnih aktivnosti. Hipoteza raziskave je bila, da bodo učenci iz eksperimentalne skupine, dosegli statistično značilno višje izboljšave pri razvoju gibalnih sposobnosti kot učenci iz kontrolne skupine. Gibalne sposobnosti, ocenjene z uporabo BOT-2 podtestov (izbrani so bili zaradi visoke veljavnosti in zanesljivosti pri ocenjevanju gibalnih sposobnosti) za fino motorično integracijo, ročno spretnost, ravnotežje in bilateralno koordinacijo, smo ovrednotili tako pred, kot po končanem intervencijskem programu v obeh skupinah. Rezultati testa Anov (dvosmerna mešana analiza variance 2x2), s katerim smo primerjali razlike med eksperimantalno in kontrolno skupino, so pokazali statistično značilne izboljšave pri fini motorični integraciji (p = 0.016), finih motoričnih veščinah (p = 0.021), bilateralni koordinaciji (p = 0.004), ravnotežju (p = 0.000) in koordinaciji celotnega telesa (p = 0.000) med udeleženci v eksperimentalni skupini. Izvedena raziskava prikazuje potencial le dveh dodatnih ur iger z žogami tedensko za izboljšanje gibalnih sposobnosti pri otrocih starih 6 do 7 let.

Ključne besede: telesna aktivnost, gibalne sposobnosti, otroci, telesni razvoj

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INTRODUCTION

In recent years, it has been increasingly recognised that motor abilities play a central role in the holistic development of children (Stodden et al., 2023). These include manual dexterity, fine motor skills, bilateral coordination, and balance as fundamental pillars that contribute to a child's overall physical, cognitive, and socioemotional development (Bonafede & van der Merwe, 2023; Gallotta et al., 2018). As children transition from infancy to early childhood, refining and improving these motor abilities becomes critical and lays the foundation for more complex physical activities and cognitive tasks (Baena-Morales et al., 2023). The age range of 6 to 7 represents a crucial period in a child's development which can be characterized by important milestones in the acquisition and consolidation of motor abilities (Rodrigues et al., 2021; Wang et al., 2023). During this time, children increasingly participate in a variety of structured and unstructured physical activities that provide them with opportunities to develop their motor abilities. Among the myriad of physical activities available, ball games have gained special attention because of their potential to promote a wide range of motor abilities while creating a fun and interactive activity (Jukic et al., 2019; Oppici et al., 2022; Vukićević et al., 2019). Furthermore, it is important to recognize that motor skills are not isolated elements of a child's development but are closely intertwined with cognitive and emotional aspects (Paoletti et al., 2023; Pellegrino et al., 2023). For instance, the mastery of fine motor skills contributes to a child's ability to handle objects with precision, which in turn improves problem-solving skills and enhances creativity (Tokuhama-Espinosa et al., 2023; Wiguna et al., 2023). Bardo et al. (2021), Campbell (2017) and Román et al. (2023) found that bilateral coordination developed through activities such as ball games had a direct impact on cognitive functions such as reading and writing. This underscores the link between motor and cognitive development. Balance, another important component promoted by these activities, goes beyond the physical realm (Román et al., 2023). It serves as a metaphorical tightrope act, shaping a child's ability to manage challenges and adapt to different situations, laying the foundation for emotional resilience (Costa et al., 2022). In addition, the enjoyment and social engagement that ball games bring provide an invaluable platform for developing socio-emotional skills (Naibaho et al., 2022; Widya Rahayu et al., 2021). Children learn to communicate effectively, negotiate rules, and manage conflict – all of which are skills that are fundamental for successful interaction in their social world. These findings highlight the multifaceted role of motor skills in child development and pave the way for a more in-depth examination of how structured ball game interventions might affect these interrelated dimensions.

Despite the apparent significance of young children's motor abilities and the role that ball games play in their development,the impact of structured ball games on the motor abilities of 6- to 7-year-olds has only been studied to a limited extent. . While some studies have investigated the effects of ball games on fine motor skills in this age group (Eldiasty et al., 2023; Klupp et al., 2023; Mir Hamid Salehian et al., 2023), there remains a research gap regarding the potential impact of such interventions on more complex motor abilities such as bilateral coordination. Existing studies have often focused either on specific motor skills or on different age groups, creating a gap in the understanding of how comprehensive ball game interventions can affect a wide range of motor abilities within this specific age group (Atiq et al., 2021; Dewi & Verawati, 2022; Lee et al., 2020; Lin & Yang, 2015; Newell & Rovegno, 2021; Pomeshchikova IP et al., 2016; Supriadi et al., 2022). To address this research gap, our study is characterized by examining the impact of an 8-week ball game intervention on the motor abilities of 6- to 7-year-olds. The unique aspect lies in the selection of motor abilities (manual dexterity, fine motor skills, bilateral coordination and balance) chosen for their fundamental role in early childhood physical and cognitive development. This study goes beyond previous research by specifically investigating the potential improvements that this structured intervention method can bring. In this way, it aims to contribute new insights to the current state of knowledge on optimizing children's motor development. To achieve this aim, we have formulated specific research objectives: We want to investigate whether the 8-week ball game intervention can lead to statistically significant improvements in manual dexterity, fine motor skills, bilateral coordination and balance in 6- to 7-year-olds.

METHODS

Participants

In this randomized experimental study, an extracurricular ball game program was compared with traditional physical education (PE). Over an 8-week period, 47 children aged 6 to 7 years participated. The sample was divided into two groups: the experimental group (n = 24) with an averageage of 6.2 ± 0.3 years, consisting of 10 boys and 14 girls, and the control group (n = 23) with an average age of 6.4 ± 0.2 years, consisting of 10 boys and 13 girls. Table 1 shows the general characteristics of the participants. Before the intervention began, all participants and their parents or guardians received an explanation of the experimental procedures and provided

informed consent. The study procedures were conducted in accordance with the Declaration of Helsinki.

Table 1. General characteristics of the participants.

Variable	**EXP Group (n = 24)**	**CON Group (n = 23)**
Gender	Boys: 10 Girls: 14	Boys: 10 Girls: 13
BH (cm)	118.4 ± 8.2	116.8 ± 10.3
BW (kg)	21.9 ± 7.3	20.9 ± 8.5
BMI (kg/m²)	15.1 ± 2.4	14.9 ± 1.7
Age (years)	6.2 ± 0.3	6.4 ± 0.2

Abbreviations: BH, body height; BW, body weight; BMI, body mass index; EXP, experimental; CON, control; n, number of participants. Values are defined as mean ± standard deviation.

Procedures

At a single visit after an overnight fast, all tests were performed by the same examiners. These tests included an assessment of motor abilities and an examination of body composition. Body height was determined with a wall-mounted stadiometer and recorded to the nearest 0.5 cm. Weight was determined with a calibrated beam scale with an accuracy of 0.1 kg.

Both groups attended regular PE classes three times a week, each lasting 45 minutes. In addition to these classes, the EXP group also participated in an extracurricular ball game training program. These training sessions, conducted by PE teachers, took place twice a week after school and lasted 45 minutes each over an 8-week period. Each training session began with a 5-minute warm-up program that included moderately intense running and drills for the specific ball game being practiced. Participants completed running exercises to improve cardiovascular fitness, agility exercises to improve coordination and dynamic stretching exercises to improve muscle flexibility. The session's primary segment featured two different ball games, each lasting 15 minutes. Following on from this, there was a 3–5-minute cool-down, incorporating static stretching exercises to support muscle recovery and flexibility. Specific cool-down exercises included static stretches that focused on the major muscle groups involved in ball games, promoting flexibility and reducing the risk of injury. The program primarily included the basics of tennis, football, floorball, basketball, etc., which are known for their ability to engage children and provide a high-intensity workout (Contreras-Osorio et al., 2021), which

point to the effectiveness of these activities in promoting physical engagement and intensity. Organizing an extracurricular ball game training program for 6- to 7-year-olds required careful planning. This included not only providing age-appropriate equipment, but also setting clear boundaries for the play area and ensuring a safe environment that encourages children to explore and learn. Safety measures incorporated into the training program included a detailed plan for age-appropriate equipment, clearly defined play area boundaries and measures to create a safe environment for the children. In addition, ball games were structured with a carefully designed sequence of activities, drinking and rest breaks were planned and tailored to the children's individual needs and abilities. Activities were adapted to the different abilities of the children to ensure the inclusion and optimal engagement of all participants. Specific examples of adaptations included providing modified equipment for children with different motor abilities, offering additional guidance for those who needed it, and adjusting the pace of activities to individual comfort and progress. Additional breaks or modified activities were introduced for children who needed more support, while those who demonstrated advanced skills were challenged with more complex tasks. This differentiated approach aimed to create an inclusive and positive environment that promoted each child's physical and cognitive development. Of particular note were the specific safety measures implemented to protect the children's well-being throughout the training program. In contrast, the control group participated exclusively in the traditional sports activities scheduled for that semester engaging in a variety of team and individual sports. The control group's activities included traditional sports such as football, basketball, athletics and gymnastics.

Motor Ability Assessment

The evaluation of motor abilities was carried out using subtests from the BOT -2 test battery. BOT -the Bruininks-Oseretsky Test of Motor Proficiency 2 serves as a standardized assessment instrument to determine motor proficiency levels in individuals aged 4 to 21 years (Deitz et al., 2007). Extensive previous research in this area has confirmed the validity of the BOT -2 test (Lam, 2011). In this study, four specific subtests were used: fine motor integration (8 tasks: circle, square, overlapping circles, wavy line, triangle, diamond, star, overlapping pencils), manual dexterity (5 tasks: making dots in circles, transferring pennies, placing pegs in pegboard, sorting cards, stringing blocks), balance (9 tasks. standing with feet apart on a line – eyes open, walking forward on a line, standing on one leg on a line – eyes open, standing with feet apart on a line – eyes closed, walking forward heel-to-toe on a line, standing on one leg on a line – eyes closed, standing on one leg on a balance bean – eyes open, standing heel-to-toe on

a balance bean, standing on one leg on a balance bean – eyes closed), and bilateral coordination (7 tasks: dropping/catching a ball – both hands, catching a tossed ball – both hands, dropping/catching a ball – one hand, catching a tossed ball – one hand, dribbling a ball – one hand, dribbling a ball – alternative hands, throwing a ball at a target). The four subtests used in this study — fine motor integration (8 tasks), manual dexterity (5 tasks), balance (9 tasks) and bilateral coordination (7 tasks) — comprise a total of 29 motor tasks. The BOT-2 subtests, standardized measures developed to comprehensively assess specific motor abilities, were selected for their proven reliability and validity in assessing motor skills affected by the intervention. These subtests form a solid basis for the outcome analysis of the study. In particular, the last two subtests, balance and bilateral coordination, together contribute to a composite measure of total body coordination.

Experimental Ball games Training Program

The duration of the experimental ball game training program is determined based on previous research recommendations. Most studies have found that the program usually extends over a period of about 2 months, with treatments often being between 1 and 2 hours per week (Hassani et al., 2022; Kolovelonis et al., 2022; Larsen et al., 2018; Vouglanis et al., 2022). The choice of a two-month duration has been identified as effective for achieving meaningful results in the development of motor skills. This duration represents a balance between providing a sufficiently intensive intervention and ensuring practical feasibility for participants and is in line with established practices in the field The ball game training program included activities for children aged 6 to 7. The selection of children aged 6 to 7 for the program was underpinned by developmental considerations. This age group is a critical stage for the acquisition of motor abilities and general physical development. The program was designed to align with the developmental milestones of children in this age group. The selected activities such as tennis, soccer, floorball and basketball are not only engaging but also tailored to the cognitive and motor abilities of 6-7 year olds.

Tennis

In balloon tennis, the children used balloons as "tennis balls" and hit them back and forth using small tennis rackets. This engaging activity allowed them to improve their hand-eye coordination and fine motor skills.

During target practice, the children were presented with a challenge as targets (hula hoops) were strategically placed on the tennis court. With precision and concentration, they aimed for the targets, trying to improve their accuracy each time.

Football

The children faced a fun challenge in a dribbling obstacle course. This course was designed to help the children improve their balance and bilateral coordination. They navigated an obstacle course of cones and markers while dribbling a small football.

In the passing accuracy exercise, the children formed pairs and passed the football ball back and forth at different distances, paying close attention to accuracy. This activity was designed to improve their fine motor skills and coordination.

Floorball

In the Stick handling practice, the children were given floorball sticks and balls. They practiced dribbling the ball around cones or markers, demonstrating their manual dexterity and fine motor skills as they moved the ball.

Passing and shooting taught the children to work together by passing the ball to each other and shooting at a goal. This dynamic activity promoted teamwork, coordination, and balance.

Basketball

In the dribble relay, children formed teams and participated in a relay race. They took turns dribbling a basketball across the court and back, demonstrating their bilateral coordination and balance abilities.

In the Basket Shooting Challenge, they practiced shooting the basketball into a basket from various distances, focusing on their hand-eye coordination and fine motor skills to improve their accuracy.

Activities to develop general motor skills

Obstacle Course

The children enjoyed navigating through an obstacle course filled with different challenges. Some of them crawled under tables, others jumped over small hurdles, and some tried to maintain their balance on one foot. In this engaging activity, they exercised their overall body coordination and balance.

Catching and throwing

With soft balls in hand, the children formed pairs and engaged in games of catch and throw. They took turns throwing the balls back and forth, exercising their fine motor skills and bilateral coordination while catching and throwing the balls accurately.

Balancing with balls

During this activity the children had a unique balancing act to perform. Balancing beams and lines were set up on the floor, and they skilfully walked along these while also balancing balls. Their concentration and coordination were put to the test as they worked on improving their balance.

In a lively game of "Simon Says," the children eagerly followed a series of commands that called for specific movements. Some touched their toes, others stood on one leg, and some clapped their hands in response to the commands. To add an extra twist to the game, soft balls were introduced. Some commands required the balls to be passed back and forth between participants, which provided an additional workout for hand-eye coordination. This entertaining game not only provided laughs, but also promoted listening comprehension and overall physical coordination among the participants.

Statistical Analysis

The statistical package SPSS version 20.0 (SPSS Inc., Armonk, NY, USA) was used to analyse the data. All test variables were subjected to a Levene test to assess their homogeneity. In addition, the normality of the data was checked using the Kolmogorov-Smirnov test, which showed that all data was normally distributed ($p > 0.05$). To evaluate the differences between the two study groups in outcomes after the intervention phase, a 2 × 2 repeated measures ANOVA was used. In addition, partial eta squared (η) was used to test the difference between the EXP and CON group (0.01 (small effect), 0.06 (moderate effect), and 0.14 (large effect)). Results were considered statistically significant when p-values were <0.05, and no corrections were made for multiple comparisons. Data is presented as mean ± SD or frequency (percentage).

RESULTS

Participants showed certain changes in their motor abilities which can be seen in the test results. An improvement was found in the results of the fine motor integration test in favour of the intervention group (p = 0.016). Significant differences were also found in the results of the fine motor skills test (p = 0.021), bilateral coordination (p = 0.004), balance (p = 0.000), and total body coordination (p = 0.000) *(Table 2).*

Table 2. Motor abilities test results and and changes from pre- to post-test in EXP and CON group.

Variable	Ball games		Control		F	*p*	η^2_p
	Inicial	Final	Inicial	Final			
Fine motor integration	13.3 ± 3.6	14.1 ± 7.2	14.7 ± 3.9	11.3 ± 4.1	6.32	0.016*	0.047
Manual dexterity	15.8 ± 2.8	17.9 ± 9.7	15.2 ± 6.3	16.1 ± 4.9	0.48	0.632	0.006
Fine motor skills	28.9 ± 8.8	32.7 ± 9.1	29.3 ± 5.9	28.7 ± 6.5	5.17	0.021*	0.035
Bilateral Coordination	17.7 ± 2.1	20.3 ± 3.8	19.6 ± 4.1	19.8 ± 6.2	9.18	0.004*	0.069
Balance	20.9 ± 5.6	23.7 ± 6.6	20.4 ± 4.5	18.5 ± 8.7	16.20	0.000*	0.197
Body Coordination	35.4 ± 6.7	42.1 ± 9.3	36.9 ± 5.2	34.9 ± 6.9	22.31	0.000*	0.286

Abbreviations: F-coefficient of the F-test; p—coefficient of significance of the differences, * at the p < 0.05 level;_p2-partial Eta squared.

DISCUSSION

This study examined the effects of an 8-week ball game intervention on 6- to 7-year-olds. Results showed a strong positive effect on motor abilities. Compared to the control group, the intervention group showed significant improvements in five of six motor ability subtests, including fine motor integration, fine motor skills, bilateral and body coordination, and balance.

Fine motor integration plays a central role in a child's overall development and includes the ability to coordinate complicated hand and finger movements. The positive effects of the ball game intervention on fine motor integration observed in this study can be attributed to several key factors. Firstly, ball games require precise hand-eye coordination, as participants must closely track the movement of the ball and react accordingly. This constant interaction between visual stimuli and motor responses may contribute to improved fine motor integration. Factors such as the complexity of hand movements involved in ball handling, the fine motor skills required for accurate ball control and the dynamic nature of ball-playing activities could

contribute significantly to the observed improvements in fine motor integration. Compared to the results of previous studies conducted by Larsen et al. (2018) and Riyadi et al. (2023), the results of this study are consistent with the notion that such activities significantly improve fine motor integration. Secondly, ball games often involve grasping and manipulating objects, such as catching, throwing, or dribbling a ball. These actions require the development of fine motor skills, including grip strength. Over the course of the 8-week intervention, participants likely practiced and refined these motor skills repeatedly, leading to improved fine motor integration, supporting the conclusions from the research conducted by the Fu et al. (2022) and Sadaruddin et al. (2022).

The unexpected absence of a positive effect on manual dexterity after the ball game intervention in 7-year-olds warrants further investigation. Compared with the results of previous studies conducted by McGlashan et al. (2017) and Tocci et al. (2022), this study's results differ in this specific aspect, which emphasises the need for a more detailed examination. One plausible explanation could be related to the particular nature of the ball games selected. Ball games involve certain aspects of fine motor coordination but may not place as much emphasis on the intricate finger movements and precision required for manual dexterity tasks, which contrasts with the results observed by the Smits-Engelsman et al. (2022) and Tocci et al. (2022). Another factor to consider is the duration and intensity of the intervention. It is possible that the 8-week time frame was not sufficient to achieve significant changes in manual dexterity, which might require longer or more targeted interventions, as suggested by Jiang et al. (2022). In addition, the assessment instruments used to measure manual dexterity may not have been sensitive enough to detect subtle changes resulting from the ball game intervention, indicating a possible discrepancy with the methods used by the Dincher (2023) and Gharaei et al. (2019). Re-evaluating the selection of assessment methods and examining a broader range of dexterity tasks may yield more insightful results in future studies. This finding underlines the importance of carefully considering these factors (the nature of the games, the duration of the intervention, individual variability, and the sensitivity of the assessment instruments) when designing and interpreting intervention studies to improve specific motor skills, as both this study and the work of Navarro-Patón et al. (2021) has illustrated.

The significant positive effects on bilateral coordination, balance, and whole-body coordination in the experimental group can be attributed to the versatility of the ball games, a finding consistent with those reported by Zhang et al. (2023) in their meta-analysis. These activities inherently require synchronized movements of both limbs and the use of trunk muscles, which

promotes the development of bilateral coordination and supports the findings of the Iorga et al. (2023) and Seifert et al. (2013). The constant changes in direction, speed, and body positioning during the ball games challenged and likely improved participants' balance and proprioceptive abilities during the 8-week intervention, consistent with the findings of Hermassi et al. (2023), Hulteen et al. (2023) and Suryadi et al. (2023) regarding the positive effects of such activities on balance and coordination.

In addition, the dynamic and interactive nature of ball games promotes the integration of sensory and motor responses, resulting in improved whole-body coordination, a phenomenon that mirrors the Aksović et al. (2023), Gül & Çelik (2021) and Mesfar et al. (2022) findings in their related research. Participants in the experimental group may have developed greater awareness of their body's movements in relation to the environment and adapted better to the demands of the games, as observed in the study conducted by the Chow et al. (2023) and Ihsan et al. (2022). The social aspect of the intervention may also have played a role, as the group dynamics and peer competition associated with ball games often motivate children to push their physical limits, a trend consistent with the findings of the Emm-Collison et al. (2022) and Toft Amholt et al. (2022). The positive results in terms of motor abilities could be attributed in part to the influence of social dynamics and peer competition. The observations and data suggest that the cooperative and competitive aspects of the ball game program encouraged participants to challenge themselves, fostering a conducive environment for skill development. This observation is consistent with the notion that social interactions may increase the effectiveness of interventions to improve motor abilities. Furthermore, the control group may not have received the same level of structured and consistent physical activity or tasks that target these specific skills, further underlining the benefits of the ball game intervention, a finding which is consistent with the Li et al. (2023) observations.

Although significant improvements in motor abilities were noted, it is important to acknowledge the limitations of this study. The current study focused exclusively on 6- and 7-year-old children. To gain a more comprehensive understanding of the effects of ball game interventions, future research should include children of different age groups, such as older children and preschool-aged children. In addition, monitoring of students' overall physical activity levels throughout the intervention period was omitted, a factor that could potentially influence overall results. Considering that most children in this age group do not yet know or have not experienced handling different types of balls and playing various ball games, the greatest advantage of the conducted extracurricular ball game program is that properly designed

instruction of these activities can significantly improve children's motor abilities compared to participation in traditional school PE.

CONCLUSION

The results of the study show that the extracurricular ball game intervention significantly improved the motor abilities of 6- to 7-year-olds compared with traditional PE. Specifically, the short-term ball game program resulted in significant improvements in balance, bilateral coordination, and overall body coordination. In addition, fine motor skills and fine motor integration were significantly improved. It can be concluded that just two additional weekly sessions of various ball games can lead to remarkable changes in the motor abilities of 6- to 7-year-olds. These results therefore support the proposal to incorporate alternative forms of ball games into the school curricula.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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