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IMPROVING PHYSICAL FITNESS OF ELEMENTARY SCHOOL STUDENTS THROUGH KIDS' ATHLETICS GAME PRACTICES

Research article

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IMPROVING PHYSICAL FITNESS OF ELEMENTARY SCHOOL STUDENTS THROUGH KIDS' ATHLETICS GAME PRACTICES

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Abstract

Kids' athletics game practices (KAGP) could be used by physical education teachers during their lessons to keep a large number of children physically active at the same time by playing the athletics. This study aimed to investigate the effects of 4-week KAGP on some physical fitness variables in children, and, to compare these affects between sexes. The study was conducted on 3rd-grade students randomly selected from a primary school. The volunteers exercised the KAGP for 4-weeks, two days per week. The KAGP (formula one, sprint/hurdles shuttle relay, forward squat jumps, and backward overhead throwing), involved straight running, running with changing direction, rolling movement, hurdling, jumping and throwing. Pre-test and post-test measurements were taken for counter movement jump (CMJ), backward overhead medicine ball (BOMB) throwing, agility (Illinois test), flexibility (sit-and-reach), and 30m sprint. Following the 4-week KAGP, the CMJ (Pre:16.04±3.33 cm; Post:18.46±2.90 cm) significantly increased, and the 30m sprint time (Pre:6.94±0.61 sec; Post:6.74±0.57 sec) significantly shorten only in girls ($p = .003$ and $p = .008$, respectively). The agility significantly improved (Pre:24.03±2.00 sec; Post:23.26±1.83 sec; $p = .01$) and the BOMB throwing distance significantly increased (Pre: 3.80±0.97 m; 4.45±1.18 m; $p = .001$) considering the overall data. Significant difference between boys and girls was observed for CMJ performance. It has been observed that games structured according to the purpose have positive effects on the strength and agility properties of children. KAGP can be used as a tool to increase physical activity and improve physical fitness in children at primary level.

Keywords: Physical activity, motor fitness, strength, speed and agility, flexibility, motor skills

1. Introduction

Physical activity (PA) is associated with improved psychological well-being, lower blood pressure, and lower risk of obesity in children. On the other hand, increment in sedentary time is determined as a risk factor for non-communicable diseases (Jago et al., 2017). PA and sedentary behaviours are continuing from childhood to adulthood, for this reason the transition period from childhood to adolescence is the focus of many PA interventions (Schwarzfischer et al., 2019). American College of Sport Medicine (ACSM) call children and adolescents to engage in at least 60 minutes per day of moderate to vigorous intensity PA, and to do resistance exercise, bone loading activity, and vigorous intensity PA at least 3 days a week (ACSM, 2017). A recommended appropriate level of PA contributes to the development of a healthy cardiovascular system, healthy musculoskeletal tissues, and neuromuscular awareness

(coordination and movement control), besides facilitating the maintenance of a healthy body weight (WHO, 2018). However, many children are not physically active enough, moreover, recent studies' findings point out that decrement in total PA begins as early as age six (Schwarzfischer et al., 2019).

Recent studies have investigated the determinants of physical fitness, as a meaningful marker of health, ways to maximize and maintain physical fitness, and its positive effects on health from an early age (Ortega et al., 2008). Regular PA increases and maintains physical fitness at any age, additionally, recent evidences suggest that early childhood influences make a significant contribution to older ages physical fitness level (van Deutekom et al., 2015). However, it has been shown that there is no increment in global levels of PA participation over the past two decades, and there is significant gender gap (Guthold et al., 2018, 2020). In addition, consistently with mentioned findings, it has been shown that there are inequalities in PA participation by age, gender, disability, pregnancy, socioeconomic status, and geography (Bull et al., 2020; WHO, 2018). In order to eliminate these problems, to apply alternative physical activities to improve physical fitness in the school environment where children from different socioeconomic cultures come together and where girls and boys can be reached together from an early age have gained importance.

However, most of the time, following a scheduled and disciplined education program makes sports activities boring. For this reason, for maintain continuing these activities, playing game and fun factors become more important, especially for children. In this context, kids' athletics game practices (KAGP) provide great opportunity to develop coordination abilities which play an important role in the development of basic functions of physical fitness (Willwéber, 2016). Additionally, KAGP provide great opportunity to develop needs of children such as inspire children's sporting enthusiasm and mutual interaction (Çalik et al., 2018). KAGP include elementary physical activities such as running, jumping, throwing, and combinations thereof. It has been determined that the kids' athletics is more beneficial than the typical track and field skill teaching method, in terms of improving the physical fitness level of elementary students (Petros et al., 2016). The majority of the research, however, were conducted on elite athletes, rather than children in physical education courses. It has been reported that compared with older children motor skill performances of smaller ones show greater variability, it is more difficult to motivate them to consistently exert maximal effort, and the attention spans of smaller children are shorter (Goodway et al., 2019; Haywood & Getchell, 2019).

This study aimed two things: first, to investigate the effects of 4-week KAGP on physical fitness in children, and, second, to compare these affects between sexes. In the current study, strength was assessed with counter movement jump (CMJ) test (cm) and backward overhead medicine ball (BOMB) throwing (m). Agility was assessed with Illinois agility test (sec), and speed was assessed with 30 m sprinting (sec). Furthermore, the flexibility was measured using the sit-and-reach test (cm).

2. Method

2.1. Study group

The study was conducted on 3rd grade students (n=36; 20 boys and 16 girls; mean height=131.69 ± 5.00 cm; mean weight= 31.98 ± 6.67 kg) selected from a primary education school which has a gym, in the provincial center of (blind peer review) city. A priori sample size was performed (G*Power, version 3.1.9.2, University of Kiel, Germany) for t tests

(matched pairs, two tailed), with effect size=0.50, power=0.80, and that accordingly to these, the sample size should be 34 participants. The participants were 8-9 years of age who were recruited from their regular physical education courses (the total class). Main exclusion criteria were having musculoskeletal limitations and spinal or hip pain that might limit the tests performance (Mayorga-Vega et al., 2015).

2.2. Experimental Procedure

At the beginning (PRE) of the study some of physical fitness such as strength, agility, flexibility, and 30m sprint were measured. Following the Pre-test measurements, the volunteers exercised the KAGP within the scope of Physical Education and Game lesson (2 x 40 minutes) for 4 weeks. The KAGP was held in the school gym two times a week for 50 minutes. The KAGP (Formula one, sprint/hurdles shuttle relay, forward squat jumps and backward overhead throwing), involved straight running, running with changing direction, rolling movement, hurdling, jumping and throwing. At the end of the 4-week experimental period (POST) the physical fitness variables were measured in accordance with the same procedures. On measurement days, before the tests were carried out, all participants were instructed to warm-up with a standardized stretching, following the 5-7 minute of running in the school gym.

2.3. Kids' Athletics Game Practices

The participants regularly played four games in the school gym twice a week for 4 weeks: (1) Formula one, (2) Sprint/hurdles shuttle relay, (3) Forward squat jumps, and (4) Overhead backward throwing. These games were selected from the book of World Athletics, as old definition International Association of Athletics Federations (IAAF) Kids' Athletics Educational Cards (IAAF, 2006).

The basic selection criteria were that the games were enjoyable and could be made within the bounds of possibility. The images of the games are shown in Figure 1. The Formula One game combines the forward roll, sprint, slalom and hurdles clearing into a complex action. The sprint/hurdles shuttle relay is a game requires mastering low obstacles clearance at running speed and the ability at organizing one's strides over a given distance. The forward squat jumps game stresses not just lower-limb strength, but also synchronization between arms and legs, symmetrical lower-limb motion, and lastly, children's acceptance of forward instability. The overhead backward throwing event helps to improve coordination between arms and legs during the throw. It requires throwing from a stable position with both feet and keeping the backward loss of balance to a minimum (IAAF, 2006).

All necessary safety precautions were taken to prevent children from being harmed during the practices and measurements (non-slip flat floor, safe equipment such as light and solid hurdles or mats for throwing events, surrounded area).

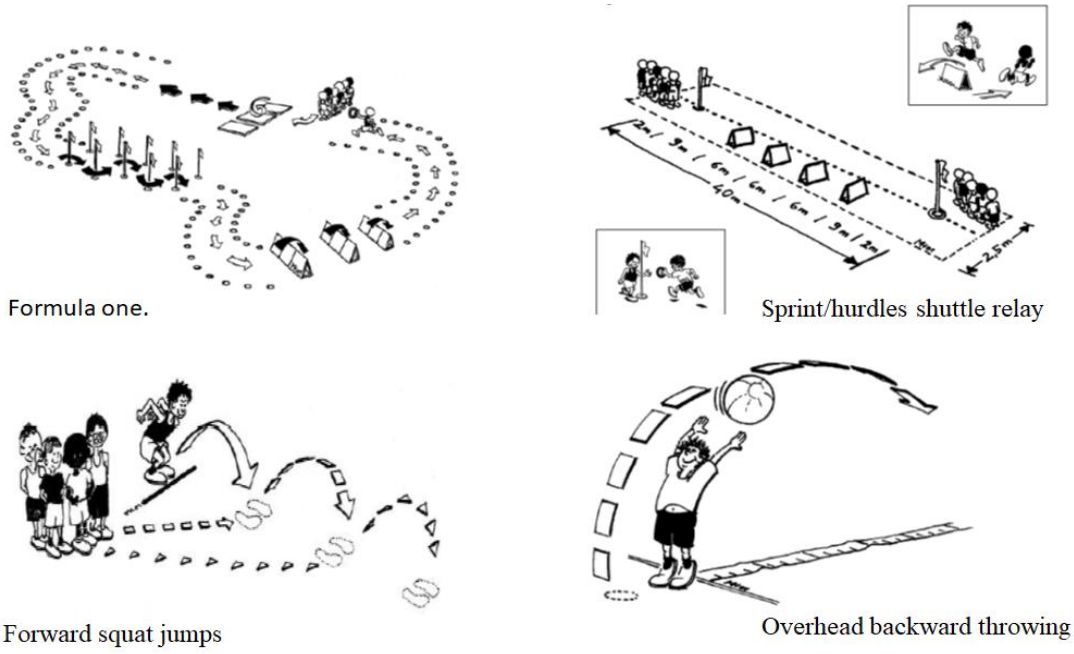

Figure 1. The selected games from the IAAF kids' athletics educational cards book (IAAF, 2006).

2.4. Data Collection

2.4.1. Anthropometric Measurements

The heights of the students were measured using a portable stadiometer (Tartı, Turkey) to the nearest 0.1 cm, additionally, their weights were measured by portable bioelectrical impedance analyser (InnerScan V, TANITA® BC601, Japan). All measurements were performed in duplicate with the average value used as the criterion.

2.4.2. Counter Movement Jump (CMJ) test

Each participant completed three maximal voluntary counter movement jumps (CMJ) after a familiarization session (learning the necessary procedures for the jump condition), and the best value of the three attempts was used for further research. The CMJ was performed using the contact mat (Smart Jump; Fusion Sport, Coopers Plains, Queensland, Australia) from an upright standing position, with the hands fixed on the hips and with a counter movement preparatory phase ended at a position corresponded to the semi-squat position. Sufficient recovery time was given among trials (more than 2 minutes).

2.4.3. Backward Overhead Medicine Ball (BOMB) Throw

First, the medicine ball throw test was demonstrated by one of the researchers. Students turned their backs to the throwing area, holding the medicine ball weighed 1 kg (Bhalla International Vinex Sports, Meerut - India) with both hands in front of them. The researchers chose this weight because it was practical and developmentally appropriate for the primary school students' group. Additionally, this medicine ball was chosen because retains its round shape and provides a good grip surface. With the researcher's command (''throw''), the students thrown the medicine ball to the back over their head, as hard as it is possible (Davis et al., 2008). Each participant performed three maximal voluntary throws, the point where the ball

first touched the ground was measured using tape measure, and the highest score was used for further analysis. The measurements were taken to the nearest 0.01 m.

2.4.4. Illinois Agility Test (IAT)

Participants started in a prone position at the starting cone. The Illinois agility course is 10 meters long and 5 meters wide (distance between start and finish points). Cones were used to mark the start, the turning and the finish points. The trial was completed when the participant cross the finish line and when no cones were knocked over (Amiri-Khorasani et al., 2010). The IAT was performed two times, and the best score was used for further analyses. IAT time was recorded using the photocell system (Fusion Sport, Smart Speed, Australia).

2.4.5. Sit and Reach Test (SRT)

The individuals were positioned for the test in a conventional sit-and-reach box, and the sit and reach test (SRT) scores were obtained using a sliding ruler centred on the top of the box (Model 01285; Lafayette Instrument Company, Lafayette, IN). The ruler's marks were placed such that the 23-cm mark corresponded to the point where the subjects' fingertips met their toes. In this method, even for participants who couldn't reach their toes, the SRT score was always a positive number. Each child sat on the floor with fully extended knees and neutral dorsiflexion ankles against the box. Each participant was told to place one hand on top of the other and reach forward as far as possible keeping the knees extended. As the participant extended forward along the box's surface, the hands were kept evenly aligned. The SRT score (in centimetres) was recorded for the final position of the fingertips on the ruler at the third repetition (Cornbleet & Woolsey, 1996).

2.4.6. 30m Sprint

A 30-meter area in a straight line was marked in the gym. In order to accelerate, the participants started running from 50 cm behind of the start line. The participants performed 2 maximal 30 m sprints, with recovery period of 3 minutes between the 30 m sprints. Time was measured using photoelectric timing gates (Fusion Sport, Smart Speed, Australia).

2.5. Data Analysis

All values were presented as mean ± standard deviation (SD). Before parametric analyses were done, the normality of distribution of the data was assessed with Kolmogorov–Smirnov test. Paired sample t-tests were performed to compare PRE and POST measures, additionally, independent sample t-tests were performed to determine differences between sexes for measured variables. Power analysis (1-β) and effect size (Cohen's d) were computed using GPower software (3.1 version). Statistical analyses were performed using SPSS 21.0 (Statistical Package for the Social Sciences, SPSS Inc.) for Windows. A p value <0.05 was accepted as statistically significant.

2.6. Ethical Consent of the Research

The study was approved by local Ethics committee (protocol number: 71368) and required permissions were obtained from (blind peer review) city provincial national education directorate (decision number: 88074293 / 605.01 / 17796474). All participants and their families were informed about the possible risks and benefits of the study and written consents were collected from parents or legal guardians.

3. Findings

The mean (SD) values of physical fitness variables of overall participants are presented in Table 1. The results indicate that the CMJ, and BOMB throwing significantly increased (p = .001) following the 4-week KAGP in 8–9-year-old children. Additionally, after 4 weeks of practices the time recorded for IAT (agility) significantly decreased (p = .01) compering to pre-measure value.

The mean (SD) values of physical fitness variables of each sex group are presented in Table 2. The findings of the current study show that after 4-week practices the distance of throwing medicine ball significantly increased, and the time of the agility test significantly decreased in 8–9-year-old children in both sexes (for girls; p = .002 and p= .046, respectively, for boys; p = .011 and p = .033, respectively). The height of vertical jump significantly improved, and the 30m sprint time significantly shorten only in girls (p = .003 and p = .008, respectively). The significant difference between sexes was observed only for pre-measure CMJ values (p = .009); the mean value for CMJ of girls was significantly lower (16.04±3.33 cm) than the mean value for CMJ of boys (19.67±4.26 cm). Additionally, the increment of CMJ height (the difference between pre-test and post-test) was significantly different between groups (p =.043). No significant differences were determined for flexibility, neither for overall data nor separated data for sexes.

Table 1. *The Mean ± SD Values of Physical Fitness Variables of Overall Participants*

Variables	**PRE**	**POST**	1-β	Cohen's d
CMJ (cm)	18.06±4.24	19.54±3.89 ‡	0.562	0.363
BOMB Throwing (m)	3.80±0.97	4.45±1.18 ‡	0.935	0.596
Agility (sec)	24.03±2.00	23.26±1.83 †	0.647	0.400
Flexibility (cm)	24.83±4.66	25.04±5.12	0.057	0.042
30m sprint (sec)	6.85±0.65	6.77±0.68	0.108	0.120

CMJ: counter movement jump; BOMB: backward overhead medicine ball; † $p<0.01$ and ‡ $p \leq 0.001$: significantly different from pre-value.

Table 2. *The Mean ± SD Values of Physical Fitness Variables of Boy and Girl Participants*

	BOYS (n=20)				GIRLS (n=16)			
Variables	**PRE**	**POST**	1-β	Cohen	**PRE**	**POST**	1-β	Cohen
CMJ (cm)	19.67±4.26	20.40±4.41	0.110	0.168	16.04±3.33 §	18.46±2.90 †	0.822	0.771
BOMB Throwing (m)	4.08±0.94	4.66±1.40 *	0.512	0.469	3.45±0.93	4.19±0.79 †	0.889	0.852
Agility (sec)	23.57±2.17	22.98±2.16 *	0.212	0.272	24.60±1.67	23.60±1.27 *	0.697	0.662
Flexibility (cm)	25.52±4.17	25.47±4.70	0.050	0.011	23.96±5.21	24.50±5.70	0.065	0.098
30m sprint (sec)	6.77±0.68	6.79±0.77	0.051	0.027	6.94±0.61	6.74±0.57 †	0.245	0.338

CMJ: counter movement jump; BOMB: backward overhead medicine ball; * $p<0.05$ and † $p<0.01$: significantly different from pre-values; § $p<0.01$: significantly different from pre-values of boys.

4. Discussion and Conclusion

This experimental study aimed to improve children's physical fitness and coordination skills using a variety of games included in the KAGP. For this purpose, 4 different games were played regularly for 4 weeks. To test the effectiveness of the practices, the selected physical fitness variables were measured at the beginning and at the end of the study and were compared within group (overall data) and between groups (between sexes). The main findings of the current study show that after 4-week practice the distance of throwing ball significantly increased, and the time of the agility test significantly decreased in 8–9-year-old children (for both sexes) ($p<0.05$ and $p<0.01$). The height of vertical jump significantly improved, and the 30m sprint time significantly shorten only in girls ($p<0.01$).

Many studies conducted on different age groups indicated that the KAGP (kids' athletics programs) improve physical fitness status and provided positive effects on the improvement of average performances in children (Čillík & Willwéber, 2018; Petros et al., 2016). In a study investigated the effects of KAGP on 1000 m running performance in 11-12 aged children (Seyrek et al., 2017); one group played the 8 minutes endurance game, one group played the formula one race game, and another group played the sprint/hurdles slalom shuttle relay game. At the end of the 8-week practice, the 1000 m running performance significantly increased in all groups (Seyrek et al., 2017). Willwéber (2016) reported that standing long jump, sit-ups in 30 s, flexed arm hang, shuttle run 4 x 10 meters, and endurance shuttle run performances significantly improved in 3rd grade students (n=16; 8-9-year-old aged boys) who were involved in the project of Kids' Athletics for a one school year (9 months). Additionally, it has been showed that 14-week of KAGP significantly improve the physical fitness status [the balance

(flamingo balance test), medicine ball throwing distance, flexibility (sit-and-reach test), standing long jump, sit up, shuttle run 10x5m, 20m sprint, and shuttle run test performances] in 10-11 aged children compared to control group (Çalık et al., 2019). Training the track and field with the Kids' Athletics curriculum has been shown to increase physical fitness and event performance in 11-12-year-old children more than the typical repeated skill teaching technique (Petros et al., 2016). As a result, wide variety of drills and multi-sport activities have a favourable impact on children's physical fitness level (Kirk, 2005; Pesce et al., 2013).

The findings of the current study are in agreement with the studies mentioned above: the physical fitness variables (sprint, CMJ, BOMB throwing, agility) significantly improved in 8–9 aged children. Davis et al. (2008) determined that, although it has indicated moderate correlation, the medicine ball throw (sitting on floor, holding the ball in front of the chest, and throwing the ball forward) is a highly reliable test of upper-body strength or power in primary school children. In the present study the medicine ball throw position involved the force generated from the trunk and lower body extremities. No significant variation was reported between the mean distances of different medicine ball throwing tests in 10-11 aged female gymnasts, meaning that any kind of medicine ball throwing tests would evaluate the upper-body strength well (Salonia et al., 2004).

Petros et al. (2016) indicated that the biggest improvement was found for speed and agility in children. In the current study the agility improved in both sex groups ($p<0.05$), and the sprint improved only in girls ($p<0.01$). Even though the 8-9 aged group was involved in the current study the findings are consistent with the literature. Similarly, Abhaydev et al. (2020) showed that the sprint, jump height, and agility significantly improved in 10-14 aged subjects following in 12-week Kid's Athletics program with no significant differences between 10-11 and 13-14 aged groups.

On the other hand, in the current study the flexibility, assessed with sit-and-reach test which is focusing on the articular mobility, did not change significantly. This could be explained by the fact that the exercises used in the current study did not deliberately aimed at improving flexibility. On the contrary, Willwéber (2016) reported that flexibility increased significantly from 19.7 cm to 21.1 cm in 3rd grade students (n=16; 8-9-year-old aged boys) who were involved in the project of Kids' Athletics for a one school year.

In conclusion, the present study indicates that the Kids Athletics is an effective practice which can be applied in physical education to improve physical fitness in both sexes, providing physical educators with an additional means to improve the quality of their lesson. Kids' Athletics uses a game-cantered approach to teaching athletics, hence the study focuses on the impact of teaching athletics with games, as opposed to other teaching methods, on inspiring kids' engagement and growing their desire for athletics. Thus, children can increase their participation in physical activity by getting acquainted with athletics practices, and they can also improve their physical fitness by having fun. Additionally, in the school environment where age, gender, and socioeconomic differences disappear, physical activity intervention programs can be carried out with the athletic kids' program in early age children, in order to prevent the negative effects of the lack of physical activity on physical fitness at older ages.

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