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Effects of High-Intensity Interval Training Intervention on Physical Fitness and Body Mass Index of Overweight Primary Schoolchildren

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ABSTRACT

Being overweight has serious health consequences for schoolchildren. Schools use different physical education (PE) programs for obesity prevention in children, but the overall positive impact of school-based interventions is questionable. This scientific work investigated the effects of high-intensity interval training (HIIT) intervention on physical fitness performance and body mass index (BMI) of overweight primary schoolchildren (seven years old males). Sixty-four boys, who had overweight, participated in this study. All participants practiced 44 PE classes. Control group (G1; n=32; mean age: 7.46±0.32 years; mean height: 123.35±3.28 cm; mean body mass: 27.81±2.32 kg; mean BMI: 17.82±0.11) performed curriculum PE during the investigation. The experimental group (G2; n=32; mean age: 7.54±0.27 years; mean height: 123.26±3.41 cm; mean body mass: 27.84±2.07 kg; mean BMI: 17.78±0.14) performed sixteen-week HIIT intervention in PE classes. Participants' height, weight, BMI, and physical fitness: push-up test, running sprint test, standing long jump test (SLJ), seat-and-reach test (SRT), and six-minute walk test (6MWT) were assessed in pre- and post-PE intervention. There were significant ($p<0.05$) differences between both groups in fitness tests and BMI values in the post-intervention period. Participants (G2), who practiced HIIT intervention, demonstrated a higher value in fitness performance tests, except for SRT. Children (G2) demonstrated significant ($p< 0.05$) lower values of BMI in the post-intervention period. A sixteen-week HIIT intervention in PE classes is effective in increasing of fitness performance and decrease of BMI in overweight primary schoolchildren. Incorporating different HIIT in the PE curriculum could be effective part of overweight prevention in primary schoolchildren.

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INTRODUCTION

Today childhood overweight and obese are growing worldwide health problems (Barros et al., 2022; Ijaz et al., 2021; Wu et al., 2021). Angawi and Gassy (2021) estimated that about 155 million children are overweight globally. It's known that being overweight or obese has serious health consequences, especially for modern children. Smajic et al. (2018) reported that an inactive childhood can pose a severe hazard to health when the child turns into adulthood. Investigators confirmed the association between physical activity (PA) risk behaviours in children (Vukelja et al., 2022) and overweight (Milanović et al., 2021). Lambrinou et al. (2020) reported the significant increase in the prevalence of obesity and the serious public health consequences of childhood overweight and obese is considered one of the most critical public health challenges. In this regard, new qualified/accurate investigations into pediatric obesity are needed (McKenzie & Baard, 2014). Experts point to the need to improve the quality of research related to the problem of childhood obesity. Park et al. (2017) insists on the need to seek diversity in terms of research participants, interventions, research procedures, and evaluation methods, along with overall quality improvement in research methodology. Nagovitsyn et al. (2021) recommend using BMI as an objective parameter for assessing the body mass of schoolchildren. Schwarzfischer et al. (2017) indicated that BMI standards are reliably related to the objectively measured PA level in this population.

It's known that primary and secondary schools are considered essential setting for general intervening in children's overweight/obesity-related behavior. Investigators point out several important reasons for successful intervention: available compulsory primary school education for all children; all schools offer curriculum PE and provide another opportunity for different PA and sports activities; all schools offer a structured educational environment where various interventions can be easily applied and, i.e. (Lambrinou et al., 2020; Pechertseva & Tanaeva, 2021). Lynch et al. (2017) reported that quality PE in primary school is a prerequisite for children's well-being. At this age, serious health threats are known (Oral et al., 2019). Main reasons: increasing levels of urbanization (Melnik, 2018), irrational nutrition (Podrigalo et al., 2020), and lack of daily PA in schoolchildren (Sgro et al., 2019). Today, schools use different programs for obesity prevention in children, but the overall positive impact of school-based interventions, including other PE interventions, is questionable. Their serious problems of increasing body weight and developing obesity in primary schoolchildren were identified (Soler-Lanagrán & Castañeda-Vázquez, 2017). About 20-25% of primary schoolchildren today are overweight or obese (Karki et al., 2019; Milasinovic et al., 2019).

Castro et al. (2018) reported that the high prevalence of overweight/obesity in childhood underscores the need for effective intervention programs capable of reversing this problematic situation. Lee et al. (2006) recommend encouraging children to perform physical exercises to prevent childhood obesity actively. Drenowatz et al. (2021) reported considerable and accurate evidence for beneficial associations of fitness profile and motor competence with body weight in schoolchildren and adolescents.

Preventing obesity requires preschool and primary schoolchildren to do 60-120 minutes of moderate to vigorous physical activity daily (Fernandez-Valero et al., 2021; Mischenko et al., 2021; Sember et al., 2018). Insufficient PA level in schoolchildren leads to a violation of the body's adaptation mechanisms. It reduces the various indicators of their physical fitness profile and motor competence. Casolo et al. (2019) indicate that primary schoolchildren have a sufficient level of PA in between lessons. Health/education professionals need to identify optimal ways to increase the level of PA of schoolchildren in PE classes. PE programs for current schoolchildren should increase children's motor mode to improve their physical condition (Moskalenko et al., 2020). Professionals recommend using various ball games, particularly football (Machado et al., 2018) and volleyball (Nagovitsyn et al., 2020), in the curriculum PE of schoolchildren. Romanov et al. (2017) reported that basic curriculum PE programs for primary schoolchildren in Russian Federation allocate more than half of the total time to motor and sports games. However, simply increasing the volume of play activity for schoolchildren does not guarantee positive results in the fight against overweight and prevention of childhood overweight. In this case, it is necessary to monitor the dynamics of BMI and the level of PA among schoolchildren. Bodnar et al. (2018) recommend solving this problem using according to the schoolchildren's health status PE methods.

Investigators reported that increasing childhood obesity prevalence has shifted the classification of healthy fitness, with 'underfit' as normal for schoolchildren (Yip et al., 2022). Health professionals are defined the physical fitness of schoolchildren as the body's condition resulting from a lifestyle that includes muscle strength, muscle endurance, cardiorespiratory fitness, flexibility, and maintaining an ideal BMI. These parameters are important indicators of children's health, as an integrated measure of the body's ability to perform regular PA. Physicians & investigators founded strong links between physical fitness and BMI status in schoolchildren, in which a high BMI may have a negative impact on some measures of physical fitness of children (Yi et al., 2019).

Scientists & health professionals emphasize the need to use special PA sessions of sufficient duration and frequency (at least three sessions per week) in PE of schoolchildren (Albuquerque et al., 2018). Travill and Wildschutt (2019) reported the lack of intensive PA sessions in PE among most of schoolchildren. Scientists, health professionals & physicians indicated that the insufficient level of development of important physical qualities: speed-power (Orlova et al., 2019; Polevoy, 2020), strength (Iermakov et al., 2020; Khudolii et al., 2019), and coordination abilities (Polevoy, 2020; Snigur, 2017) of preschoolers and primary schoolchildren aged six and eight years. Health/educational professionals & physicians reported the need to use special PE methods to ensure the harmonious physical development of children. These PE methods should have a diverse motor and speed-power basis (Orlova et al., 2019; Osipov et al., 2021). On the other hand, Thomaidou et al. (2021) state that creative dance-based movements and different creative movement PE programs may substantially boost children's creative potential but don't provide children with enough opportunities to develop a wide range of their motor competence and motor skills. There is scientific knowledge that recommends using functional strength training in PE of adolescents who have overweight (Volkova et al., 2018). There is evidence of positive use of high-intensity interval training (HIIT) programs in PE for schoolchildren with obesity (Cvetković et al., 2018). Espinoza-Silva et al. (2019) reported that HIIT interventions caused significant improvements in the cardiorespiratory capacity and BMI levels of overweight/obese schoolchildren (Espinoza-Silva et al., 2019). However, the majority of positive results in schoolchildren aged nine and eleven years were found (Delgado-Floody et al., 2018). Krivolapchuk and Chernova (2018) reported of the positive impact of high-intensity training in PE on preschool children aged five and six years. Unfortunately, there was no found full and robust knowledge about effective PE programs based on motor and speed-power training for seven years old primary schoolchildren with overweight.

The scientific review suggested a lack of knowledge about PE training programs (based on motor and speed-power training) for overweight primary schoolchildren (seven years old males). This scientific work investigated the effects of HIIT intervention on physical fitness performance and BMI of overweight primary schoolchildren. It was hypothesized that this specific HIIT intervention would confer greater improvements in physical fitness and correcting of BMI of overweight primary schoolchildren than curriculum PE.

METHODS

Study Group

Sixty-four primary schoolchildren (boys), who had overweight, participated in this study. Study participation was voluntary. All participants were selected from the four primary classes in two public primary schools, which had a united location and infrastructure (including school gyms). The overall inclusion criteria for all participants were: A) medical qualification for PE classes; B) subject age seven years old; C) overweight (excess of BMI standards for this population). The overweight equivalent to BMI of 17.3-22.0 kg/m2 at seven years old male (World Health Organization BMI for age: five to nineteen years). We confirm that all scientific ethical principles were observed in full. Firstly, all children's parents and primary school administrators were previously informed of the main purposes of the investigation, associated positive benefits, experimental procedures and tests, and future scientific potential. Secondly, informed consent from all parents and primary school administrators to conduct research and publish the results were received before the PE intervention period. Thirdly, this scientific work was implemented after approval by the university ethics committee SibFU (Institute of Physical Culture, Sport and Tourism, Protocol no. 18/2021) following the Helsinki declaration for scientific research with humans.

Data Collection Tools

The overall duration of this investigation conducted about sixteen week (September–December 2021). All children were randomly formed into two equal study groups as control group (G1) and experimental group (G2). Both groups had similar anthropometric and body mass characteristics. Children (G1) had mean age: 7.46±0.32 years; mean height: 123.35±3.28 cm; mean body mass: 27.81±2.32 kg; mean BMI: 17.82±0.11. Children (G2) had mean age: 7.54±0.27 years; mean height: 123.26±3.41 cm; mean body mass: 27.84±2.07 kg; mean BMI: 17.78±0.14. Four primary classes (A, B, C, D) participated in this study, but the number of participants from each class was not equal. Twelve boys from class «A», nine boys from class «B», seven boys from class «C», and four boys from class «D» were included in the control group. Seven boys from class «A», ten boys from class «B», six boys from the class «C», and nine boys from class «D» were included in the experimental group.

All children participated in regular 45-minute PE classes conducted by qualified PE teachers three times a week. These PE classes were held on Mondays, Thursdays, and Saturdays from 11.00 a.m. to 11.45 a.m. at a school gym (except for school holidays for children – one week in October 2021). In total, 44 PE classes (1980 min) were held. All participants

started and completed this study; however, not all participants visited the full PE classes due to respiratory diseases (six participants [G-1] and four participants [G-2] missed from 7 to 10 days, and four participants [G-1] and five participants [G-2] missed from 10 to 14 days during the study).

The control group (n=32) practiced adequate warm-up (walk in place - 30-40 sec, look arounds, arm circles, high reaches, toe touches, side bends, hand claps, knee raises, lateral step reach, ski hops, hip swirls (the duration of each exercise ranged between 12 and 16 reps), jog in place - 30-40 sec) and cool-down (walk in place - 30-40 sec, side stretch reach up, reach up, but don't jump up, ground down, touch your toes, butterfly stretch, quad stretch, calf stretch. The duration of each exercise ranged between 45 and 60 sec); athletics (running and hopping), gymnastics (individual balance, partner balances, shoulder rolls, circle rolls, rotation, and jumping), and different motor and sports games during these PE classes. Motor and sports games are based on different movements with a ball (play in football, handball, and other plays). Experimental group (n=32) practiced adequate warm-up and cool-down, running, hopping, gymnastics exercises, and HIIT exercises instead of sport plays.

The sixteen-week HIIT intervention for the experimental group (G2) was programmed in duration and intensity following scientists' & health professionals' recommendations regarding HIIT in healthy and overweight/obese schoolchildren (Cvetković et al., 2018; Delgado-Floody et al., 2018; Eddolls et al., 2017; Espinoza-Silva et al., 2019). The intervention program had simple high intensity exercises, with the development of basic motor skills, as the main strategy. The exercises lasted 30 sec to 45 sec, with a recovery time of 20 sec to 30 sec, working progressively over a period of 15−20 min of each PE class. The training program had: sprints of 10 m to 20 m; Push-ups; Bench step-ups: step-ups onto a low bench (15-20 cm); Crab walks and Crab toe touches; Inchworms; Dynamic Planks; Burpees. Every HIIT physical exertion was monitored during the investigation. Participants (G2) used heart rate monitors Polar H9 (China) to gather heart rate data while performing intensive physical exceptions. The values of mean heart rate used in HIIT were determined based on data from the assessment and monitoring of submaximal exercise-induced changes in the cardiovascular system of children (Jankowski et al., 2015; Van Camp et al., 2022). In our case, the target pulse rate zone for seven years old males with overweight to improve fitness is 145 to 175 beats per min.

The overall knowledge about HIIT and curriculum training programs in PE classes is outlined in Table 1.

Table 1
Training PE Program for All Participants During the Investigation (September– December 2021)

Training program (45 min)	
G-1 (n=32)	**G-2 (n=32)**
Common Warm-up (5-8 min)	Common Warm-up (5-8 min)
Common Gymnastics (5-10 min)	Common Gymnastics (5-10 min)
Athletics (5-10 min)	HIIT (15-20 min)
Motor and sports games (10-15 min)	Sprints (10-20 m) – 2 min; Rest – 30 sec; Push-ups – 30 sec; Step-ups onto a low bench (15-20 cm) – 2.5 min; Rest – 30 sec; Crab walks – 2 min; Rest – 30 sec; Burpees – 1 min; Rest – 30 sec; Step-ups onto a low bench (15-20 cm) – 2.5 min; Rest – 30 sec; Inchworms – 1.5-2 min; Rest – 30 sec; Dynamic Planks – 1.5-2 min; Rest – 30 sec.
Common Cool-down (5-7 min)	Common Cool-down (5-7 min)

G-1: Control Group
G-2: Experimental Group
HIIT: High-intensity interval training

Data Collection Procedure

Simple and good reliability and validity measurements of the physical fitness performance of participants were used. The variables (fitness tests) for this study were selected according to scientists' recommendations who studied the physical fitness performance of seven years old males. Well known that the normative values of physical fitness (muscle strength, muscle endurance, cardiorespiratory fitness, and flexibility) and BMI are essential references for monitoring the fitness data from schoolchildren. Esmaeilzadeh (2012) recommend standing long jump (SLJ), 30-meter sprint, and push-ups, for the examine the differences in physical fitness among seven to eleven years old males with varying BMI. Yip et al. (2022) recommend the 6-minute walk test (6MWT) to examine exercise tolerance and endurance and the sit-and-reach test (SRT) to examine of the flexibility of the lower back and hamstring muscles for six to seventeen years old males with varying BMI.

Before fitness tests assessments, all participants performed a special warm-up guided by two PE teachers, which consisted of walking and jogging followed by joint exercises (10-15 min). After detailed familiarization (full verbal instruction, high-quality visual demonstration, and quality performing one trial depending on test requirements), participating children used the test procedures. All children completed the test procedures twice (the overall interval between test procedures was sixteen-week). Four qualified test rates performed the test procedures. All test rates were qualified PE teachers.

The push-up test (measurement of upper-body endurance). The correct push-up version (McManis et al., 2000) was explained and demonstrated to all participants. Only correctly performed push-ups were counted in this test. The total number of correctly performed push-ups was measured for the analysis.

The standing long jump test (SLJ) is widely applied to assess lower body strength. The correct SLJ version (Espinosa-Sánchez, 2017) was explained and demonstrated to all participants. Three attempts are allowed for each participant. Recorded the longest distance jumped in best attempting.

The running sprint test (30 m) with standing start (measurement maximum sprint speed). This speed test requires the participant to sprint as fast as possible, over 30 m. The correct sprint test version (Castro-Piñero et al., 2010) was explained and demonstrated to all participants. To measure the exact time of participants, a mechanical stopwatch SOPpr-2a (Russia) with the accuracy of ± 1.0 sec per 30 min was used. An accurate time of 30 m run time was measured for the analysis.

The 6-minute walk test (6MWT) is the most commonly used and well-established test to measure functional exercise capacity. The 6MWT was conducted according to standardized test protocol described by scientific works (Klepper & Muir, 2011; Özcan Kahraman et al., 2019). Standard 6MWT version was explained and demonstrated to all participants. In this case, there was no warm-up before the test procedure. Mechanical stopwatch SOPpr-2a (Russia) with an accuracy of ± 1.0 sec per 30 min was performed to measure of exact time of participants. The accurate time of 6MWT performance for each participant was recorded.

The seat-and-reach test (SRT) is used to evaluate flexibility of the low back and hamstring muscles. The standard SRT version (Cornbleet & Woolsey, 1996) was explained and demonstrated to all participants. The SRT score (in cm) was recorded and used for analysis.

BMI calculator. The participants' height and weight indicators were measured for the BMI calculation procedure. Standard procedures for weight and height measurements for children (Lionti et al., 2013) were performed twice during the investigation (September and December 2021). For these procedures, the electronic weighing scale (Tanita BC-730, China) and certified stadiometer (Seca 264 Wall Mounted Wireless 360, Germany) were used. BMI (kg/m2) indicators were calculated from estimates of heights and weights. The participants' BMI (normal weight or overweight) was assessed with World Health Organization (WHO) BMI standards for this population. Normal weight equivalent to BMI 13.2-17.2 kg/m2 at seven years old male; overweight equivalent to BMI 17.3-22.0 kg/m2 at seven years old male (WHO BMI for age: five to nineteen years).

Data Analysis

Data analysis was performed with the statistical program – IBM SPSS Statistics for Windows 20.0 (Armonk, NY: IBM Corp.). All collected data are presented as means ± standard deviations (Means ± SD). The distribution of each variable was examined using the Kolmogorov-Smirnov normality test. Homoscedasticity of variance was verified with the Levene's test. All variables presented normal distribution. The independent t-test to compare differences between groups for examined variables, and a dependent t-test for pre-test and post-test differences for examined variables in each group, were applied. Complementarily, Cohen's d effect size (ES) was calculated, using Hopkins' spreadsheets (Hopkins et al., 2009). For this investigation, the level of significance was set at $p<0.05$.

RESULTS

We found that there were no significant differences between both groups in variables of fitness tests and BMI status in the pre-intervention period (September 2021). There were trivial (ES < 0.20) magnitude in fitness tests and small (ES – 0.20-0.59) magnitude in the measurement of BMI between groups.

The dependent t-test demonstrated that there were significant ($p<0.05$) differences between all pre- and post-intervention variables in favor of the post-intervention variables for each group. Both groups significantly ($p<0.05$) improved their level of physical fitness and decreased BMI status during the intervention. The independent t-test demonstrated that there were significant ($p<0.05$) differences between both groups in values of fitness tests and BMI status in the post-HIIT period (December 2021) in favor of the experimental group (G-2). Participants (G-2), who performed HIIT in PE, demonstrated a higher value of physical performance in fitness tests, except for SRT. Also, these children demonstrated significant ($p<0.05$) lower values in the measurement of BMI. There were small (ES – 0.20-0.59) magnitude in sprint and 6MWT tests, moderate (ES – 0.60-1.19) magnitude between groups in push-up and SLJ tests, and BMI measurement. There was a trivial (ES < 0.20) magnitude between groups in the measurement of SRT. The overall information about participants' values of fitness performance and BMI status in the investigation period is presented in Table 2.

Table 2
The Overall Findings in Participants' Values of Physical Fitness and BMI During the Investigation Period

Tests	G-1	G-2	$p <$	ES
Pre-intervention period (September 2021)				
Push-up	10.54±3.41	10.45±2.29	0.441	0.015
Sprint – 30 m (sec)	8.02±2.54	8.28±2.43	0.293	0.052
6MWT (m)	365.09±109.67	382.66±107.62	0.233	0.118
SLJ (cm)	109.62±22.44	107.25±15.28	0.301	0.084
SRT (cm)	12.58±2.49	12.55±2.31	0.494	0.002
BMI	17.82±0.11	17.78±0.14	0.091	0.231
Post-intervention period (December 2021)				
Push-up	12.35±2.55	13.54±3.13	0.028*	0.640
Sprint – 30 m (sec)	7.45±1.73	7.05±1.64	0.043*	0.570
6MWT (m)	470.19±106.32	507.18±105.91	0.046*	0.559
SLJ (cm)	130.06±20.63	137.46±18.53	0.033*	0.611
SRT (cm)	18.49±3.82	18.74±3.91	0.344	0.065
BMI	17.73±0.14	17.47±0.22	0.012*	0.872

p: independent-samples t-test
**: statistically significant*
ES: effect size (magnitude of association between the variables)

DISCUSSION

This scientific work investigated the effects of HIIT in PE classes on fitness performance and BMI of overweight primary schoolchildren (seven years old males). We investigated those participants (G-2), who performed HIIT in PE classes, demonstrated a significant ($p<0.05$) higher values in fitness performance, excluding flexibility (SRT), and significant ($p<0.05$) lower value in BMI status, compared to participants (G-1), who performed curriculum PE. These positive findings corroborate the hypothesis that HIIT would confer greater improvements in fitness and correct of BMI status of overweight primary schoolchildren, than curriculum PE. The practical importance of scientific data obtained in this scientific work is accurate knowledge about the strong positive effects of HIIT intervention in PE classes, for improving physical fitness and BMI correcting in primary schoolchildren (seven years old males) with overweight. This investigation complements the topical scientific knowledge about the effects of HIIT on fitness performance and BMI status of overweight seven years old males.

In current, an increasing number of scientific studies have investigated the possible relationship between overweight/obesity and motor competence, physical fitness performance, and the level of adherence to participation in regular PA during primary schoolchildren. Topical scientific works found a positive association between better physical

fitness performance and participation in regular PA, including curriculum PE in schoolchildren (Barros et al., 2022; Drenowatz et al., 2021). Wu et al. (2021) reported that motor fitness performance in primary schoolchildren comprises several components of physical fitness, including speed, strength, flexibility, and agility, that is associated with the development of motor skills and enhanced performance in sports activity in schoolchildren aged seven to ten years. Also, it was found that a strong association between motor fitness performance and PA that increases gradually during childhood and adolescence and is mediated by physical fitness, perceived physical exercise ability, and obesity. However, the overall proficiency of motor fitness performance in primary schoolchildren has been found to be insufficient. Hardy et al. (2013) reported that the prevalence of motor fitness mastery among primary schoolchildren was rarely above 50% during 13 years of school-based surveys. Skowroński et al. (2019) reported that standard curriculum PE classes proved to be insufficient for the successful development of gross motor skills of primary schoolchildren, especially for boys. Scientists indicate that a possible motor skill proficiency barrier exists already in seven to ten years old primary schoolchildren. The uninterrupted development of motor fitness and physical fitness performance is crucially important for supporting the promotion of regular PA and successful motor skill development in healthy primary schoolchildren (Wu et al., 2021). Our investigation suggested that HIIT in PE can have strong positive effects on fitness performance (including muscle strength, speed, and cardiorespiratory fitness) and BMI in overweight schoolchildren (seven years old males). In this case, our investigation corresponds to general scientific trends in the successful development of motor skills and motor fitness mastery among primary schoolchildren.

Angawi and Gassy (2021) reported that preventing childhood overweight/obesity interventions to manage weight gain in school settings had various positive and insignificant findings. The majority of interventions that emphasized PA, documented favorable findings. Those PA interventions were associated with a greater percentage of moderate-to-vigorous and vigorous PA daily. The PA interventions encouraged regular PA for > 60 min in a day, were also associated with a significant reduction in BMI, with the greatest effect sizes in overweight/obese children. It can be concluded that vigorous PA is a necessary condition for success in preventing childhood obesity. Cvetković et al. (2018) state that defined types of PA: recreational football and HIIT sessions elicited improvements in muscular and cardiorespiratory fitness performance in schoolchildren, who performed this training in PE. In contrast, schoolchildren, who performed only curriculum PE, increased BMI, body mass, and fat mass. The positive findings of HIIT interventions to correct body mass and improve

the cardiorespiratory capacity of overweight/obese children are presented in scientific literature. Investigators state the significant positive impact of the 28-week HIIT protocol on physical fitness performance and BMI of schoolchildren (Delgado-Floody et al., 2018). Scientists found that a 28-week HIIT intervention improved the anthropometric and cardiovascular parameters of schoolchildren. Also, this HIIT intervention applied in the school PE allowed for reducing the proportion of obese schoolchildren (Espinoza-Silva et al., 2019). However, most positive findings were obtained in nine to eleven years old children and older. Our investigation suggested the strong positive impact of sixteen-week HIIT on fitness performance and correction of BMI in boys (seven years old schoolchildren) with overweight and complemented existing scientific knowledge.

Tsiros et al. (2013) found a significant decrease in motor performance in obese schoolchildren during the 6MWT. Furthermore, other investigators state that overweight schoolchildren had worse speed and power performance in the 10-m and 20-m sprints and SLJ test; than non-overweight schoolchildren (Colella et al., 2009). Castro-Piñero et al. (2010) reported that overweight/obese boys had poorer sprint performance, than their non-overweight counterparts. Our investigation confirms the influence of body weight status on sprint performance in primary schoolchildren with a negative focus on the participants (G-1), who had the largest mean value of BMI in post-investigation. Participants (G-2), who had a lower mean value of BMI, demonstrated a better result in the sprint in the post-investigation test. Özcan Kahraman et al. (2019) presented reference values for 6MWT in healthy preschool and six to twelve years old primary schoolchildren. The mean distances for seven to eight years old children of 488.23-545.07 m. Also, Klepper and Muir (2011) reported that seven to eleven years old schoolchildren, who were overweight or obese, had a mean 6MWT of 518.50 m. Our investigation demonstrated that participants (G-2), who performed HIIT in PE, showed a significant improvement in the performance of 6MWT (from 382.66 m to 507.18 m) and approached the mean performance of 6MWT in healthy children. Our findings have confirmed the hypothesis of this investigation that HIIT would confer greater improvements in fitness performance of overweight schoolchildren (seven years old males).

Investigators presented accurate knowledge of the values of SRT in healthy primary schoolchildren. Cornbleet and Woolsey (1996) state that a mean SRT value of 24 cm for children five to twelve years old. Milanovic et al. (2019) state that a mean SRT value of 18 cm for overweight boys nine to fourteen years old. Our investigation demonstrated that participants, who have overweight, demonstrated a mean SRT value of 18 cm in the post-intervention period. These findings were equal for all participants, regardless of the PE

program. Sacchetti et al. (2012) investigated that BMI in schoolchildren was negatively correlated with the SLJ test and speed test, while no reliable association was found with tests measuring back flexibility. Oral et al. (2019) also confirmed that there is no reliable association between physical flexibility and obesity indicators in overweight children. Being overweight negatively effects on physical fitness of children but does not cause problems with physical flexibility. We can argue that there were no significant differences in physical flexibility assessments (SRT) between participants in our investigation.

Any inferences presented in this scientific work have some important limitations. These limitations are associated with the overall low number and young chronological age of studied children. In spite of being homogeneous in terms of chronological age (seven years old), all participants were still in the natural process of growth and maturation, and that could have interfered with their perceived intensive physical exertion during PE classes. In addition, there was also no full and accurate information on health-related behaviors, such as daily PA or participation in different sports activity, which unquestionably affected fitness performance and motor competence in participants. Possible overwork or lack of full recovery after the physical exertion of the participants may have a significant impact on the final result of our investigation (in particular, post-investigation fitness test results). Also, we should be acknowledged, as an important methodological limitation of this investigation, the lack of a particular control group (primary schoolchildren seven years old males), who had normal BMI and practiced standard curriculum PE. On the other hand, the utilization of strong and good validation tests that assess various and important components contributing to fitness performance and motor competence of participants, along with a stringent test protocol that was implemented consistently across all test assessments, should be considered a strong part of this investigation.

It should be noted, that limited published scientific knowledge on the improvement of physical fitness performance in overweight primary schoolchildren (seven years old males), emphasizes the need for future investigations can provide viable and accurate knowledge for the implementation of various HIIT experiences that improve motor competence and fitness performance of primary schoolchildren with overweight, particularly during curriculum PE in school.

CONCLUSION

This investigation suggested that a sixteen-week HIIT has a strong favorable effect on to increase of fitness performance and decrease of BMI in overweight primary schoolchildren

(seven years old males). Overweight schoolchildren, who practiced HIIT intervention in PE, demonstrated a higher fitness performance and lower BMI values, than overweight schoolchildren, who had not applied such intervention in PE classes. Although it requires further investigation, the incorporation of different motor and functional training (based on HIIT or other functional training protocols) in PE classes, could be effective part of overweight prevention in primary schoolchildren. Also, future investigations are needed to test the specific interventions addressing different contexts of daily PA of children (e.g., home and school) to help control childhood overweight.

PRACTICAL IMPLICATIONS

The application contribution of this investigation is to develop and test a specific sixteen-week HIIT in PE (based on motor, functional, and speed-power training), which enable to increase in fitness performance and decrease in BMI of overweight primary schoolchildren, more efficiently. This HIIT program can be used by PE teachers and parents to control the physical performance and BMI status of primary schoolchildren, especially seven years old males, who have overweight.

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Authors' contributions

The first author contributed to the conceptualization, methodology, design of the study, and supervised the general processes. The second and third authors carried out the data curation and analysis, and validated of the methodology governing this study. The fourth author collected data, and supported the tools selection.

Declaration of conflict interest

There is no conflict of interest to be reported.

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