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Research article

FUNCTIONAL TRAINING VS. PHYSICAL EDUCATION CLASSES: THE EFFECTS ON PHYSICAL PERFORMANCE IN PRIMARY SCHOOL GIRLS

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Abstract. *This study aimed to determine the effects of two training methods on the strength and mobility of trunk muscles in primary school girls. The sample of participants included 596 girls aged 11 to 15. The participants were randomly assigned to two groups: 1) an experimental group (n = 314) that performed a functional training (FT) program; 2) a control group (n = 282) that performed regular Physical Education (PE) classes. The experimental program was implemented during regular PE classes over a period of 16 weeks, where 3 training sessions were conducted per week, lasting 45 minutes each. The FitnessGram battery of tests was used to estimate the strength and mobility of trunk muscles at the initial and the final measurement. The following tests were used: Curl up, Incline push-ups, and dynamic and static Trunk lift tests. The results of the two-factor ANOVA showed significant ($p < 0.001$) improvements in each test for both groups. The magnitude of the effect size ranged from medium to large and differed between the methods in all tests except for abdominal muscle strength. These findings indicate that both training programs are beneficial for developing trunk muscle strength and mobility in primary school girls. Future research should consider investigating differences between the methods in primary school students.*

Key words: *functional training, physical education, elementary school, core muscles, students*

1. INTRODUCTION

As a curricular subject focused on physical development and health, physical education represents an integral part of the education system (Milanovic & Radisavljevic-Janic, 2018). The main goals of physical education (PE) include promoting health in primary and secondary education (Coledam et al., 2018). In this regard, the previous research has

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demonstrated that PE classes increase daily physical activity (Pate, O'Neil & McIver, 2011) and moderate to vigorous activities (Chen, Kim, & Gao, 2014). Moreover, physical education interventions were associated with increases in fundamental motor skills regardless of the frequency or duration of PE classes (García-Hermoso et al., 2020).

In addition to the mentioned benefits of PE classes, the positive effects of functional training have been reported in the literature. Over the last decade, functional training has become a globally applicable training method, considered by many to be a better alternative than traditional resistance training for the development of muscle strength (Weiss et al., 2010). What is more, functional exercises are defined as the work performed against resistance to the intention that the generated force directly benefits the activities of daily living and sports-related movements (Kreamer et al., 2002). Moreover, functional exercises are designed to specifically improve activities in everyday life (Beckham & Harper, 2010) by stimulating the neuromuscular system through multi-joint and multi-planar movements (Boyle, 2004). In practical terms, functional training involves a host of ballistic movements, manifested through strength and agility exercises with training tools such as resistance bands, medicine balls, and unstable surfaces (Ives & Shelley, 2003).

Notwithstanding, the definitions and the utilization of functional training greatly vary in the existing literature. Furthermore, experimental research carried out in order to establish the benefits of functional training is specifically focused on improving functions in older adults and military personnel (Aragão-Santos, de Resende-Neto & Me, 2020; Guler, Tuncel, & Bianco, 2021; Haddock et al., 2016; Liu et al., 2014; O'Connor et al., 2017; Shaikh & Mondal, 2012). Contrary, limited data is available regarding the effects of functional training on fundamental motor skills in youth. Functional training was reported to be more effective than traditional training for improving movement quality and fitness performance in school-age girls (Liao, Li, & Wang, 2019). Further, after 16 weeks of an experimental program, Marković (2015) reported better improvements in muscle strength in primary school students who performed functional exercises compared to those who attended regular PE classes. In the latest study, Branco et al. (2021) investigated the effects of functional and sports training programs on overweight adolescent girls. However, the results have shown no significant differences between the methods since both physical activity models were effective in improving obesity-related health parameters (Branco et al., 2021).

With insufficient data regarding functional training and primary school students, opposite statements were made by the aforementioned authors. The claims differ when it comes to the research conducted on various populations. Despite the evidence in favor of functional exercise (Da Silva-Grigoletto et al., 2019; de Resende-Neto et al., 2021; Yildiz, Pinar, & Gelen, 2019), numerous authors doubt its superiority over traditional principles (Aragao-Santos et al., 2018; Bonney, Ferguson, & Smits, 2017; Branco et al., 2020; Mcweeny, Boule, Neto, & Kennedy, 2020).

Based on the above mentioned, it is evident that further research is needed in order to determine the impact of functional training on morphological characteristics and fundamental motor skills, especially in youth. Therefore, this study aimed to examine the effects of functional training and traditional PE classes on the strength and mobility of trunk muscles in elementary school girls.

2. METHODS

2.1. Study design

A design of two groups, a pretest-posttest, randomly controlled trial, was used in this study. In randomized order, participants were assigned to two groups: 1) an experimental

group (n = 314) which performed a functional training (FT) program; 2) a control group (n = 282) which performed regular PE classes. Randomization was done using Excel software. The experimental program lasted 16 weeks and was implemented during regular PE classes. Each week of the program consisted of 3 training sessions, lasting 45 minutes each. Before the beginning of the program, the initial measurement was carried out by qualified specialists. After the intervention, the same testers conducted the final measurement using the same order and procedure as during the initial measurement.

2.2. Participants

This study included 596 elementary school female students. All participants were students of the 5th to 8th grade, aged 11 to 15. Exclusion criteria were adopted to ensure the participants' physical status. Participants were excluded from the study if they were regularly involved in any sports-related programs 2 times or more per week. Further, if a student had any injury, surgery or functional limitation that would affect the health status and the experimental procedure, she would be prevented from participating. In addition, any student previously advised to avoid muscular strain by a health professional regarding any contraindications was excluded.

All participants and their parents/guardians were informed about the experimental procedures, and provided written informed consent prior to participation. The method was approved by the Ethics Committee of the Faculty of Sport and Physical Education with all procedures conducted in accordance with the Declaration of Helsinki.

2.3. Procedures

Measurement of anthropometric characteristics

Measurements of body height were carried out with an anthropometer to the nearest 0.1 cm (anthropometer according to Martin). Body composition parameters were collected using an electronic scale (HBF-511B-E; Omron Healthcare) to the nearest 0.1 kg while participants were barefoot, wearing the clothes they practice in (Đurašković, 2001). The anthropometric characteristics of the sample are presented in Table 1.

Table 1 Anthropometric characteristics of the Functional Training group (n = 314) and the Physical Education group (n = 282).

Sample characteristics	Grade			
	5th	6th	7th	8th
Functional Training group				
Body height (*cm*)	150.14 ± 8.57	157.30 ± 6.33	160.23 ± 6.35	166.70 ± 8.00
Body mass (*kg*)	41.07 ± 8.25	44.96 ± 6.97	51.72 ± 8.95	56.80 ± 10.11
Body mass index (kg/m^2)	18.14 ± 2.91	18.19 ± 2.87	20.07 ± 2.80	20.35 ± 2.59
N	64	89	101	60
Physical Education group				
Body height (*cm*)	154.02 ± 6.61	156.12 ± 6.19	161.57 ± 7.13	164.23 ± 8.04
Body mass (*kg*)	43.67 ± 9.27	43.03 ± 8.27	52.48 ± 9.22	53.61 ± 9.61
Body mass index (kg/m^2)	18.26 ± 2.75	17.58 ± 2.69	20.06 ± 3.11	19.76 ± 2.48
N	61	90	79	52

Muscle strength and mobility testing

To evaluate the strength and mobility of trunk muscles, the subtest from the FitnessGram battery of tests was used. The FitnessGram represents a multi-component standardized method which is a commonly used tool for assessing physical fitness in primary and secondary students. It is used to assess three general components of health-related physical fitness: *aerobic capacity*, *musculoskeletal fitness*, and *body composition*. The FitnessGram battery of tests, which has shown considerable validity (Morrow, Martin, & Jackson, 2010), encompasses musculoskeletal fitness, including muscle strength, muscular endurance, and flexibility (Meredith & Welk, 2010).

The tests, both initial and final, were conducted following the instructions provided in the Manual (Meredith & Welk, 2010). The method was previously described and used to assess muscle strength and mobility in primary school boys (Marković, 2015).

The participants performed the following tests:

1. Curl up test - abdominal muscles strength (AMS);
2. Trunk lift test (dynamic) - lower back muscles strength (LBMS);
3. Incline push-ups - upper body strength (UBS);
4. Trunk lift test (static) - thoracic spine mobility (TSM).

Functional training program

The intervention program was conducted over 16 weeks. Each week of the intervention program included three training sessions lasting 45 minutes. Training sessions consisted of three phases: *the warm-up phase*, *the main phase*, and *the cool-down phase*.

The purpose of the warm-up phase was to adequately and gradually prepare participants for the workload and intensity of the main phase. Therefore, at the beginning of every training session, all participants in the FT group underwent a 10 min warm-up consisting of moderate-intensity jogging, static and dynamic stretches, and shaping exercises. The main phase consisted of three to five functional exercises, predominantly focused on developing trunk muscle strength and mobility. The exercises were performed in three sets, with the training volume presented in seconds. Each set was followed by a 30 second period of rest. Completing the exercises in the main phase lasted approximately 30 minutes, where the exercises were performed both with and without training tools. The equipment used during the intervention period included pilates bands, power bands and medicine balls. An example of the main training phase design for one week is presented in Table 2. The primary goals of the

Table 2 The example of exercises performed in the main training phase during 1 week in primary school girls.

	Main phase 1	Main phase 2	Main phase 3
Exercise	Elbow plank	Plank on a medicine ball	Side elbow plank
	Split squat with power band pull	Kneeling push-ups with a medicine ball	Split squat with overhead band pull
	Glute bridge with a medicine ball	Deadbug	Lunge with trunk rotation
	Bodyweight single leg deadlift	Trunk rotation with a powerband	Deadlift with powerband
Sets (*n*)	3	3	3
Duration (*sec*)	30 - 45	30 - 45	20 - 60
Rest (*sec*)	30	30	30

cool-down phase were to reduce the heart rate and to lower the body temperature. The cool-down phase represented the last part of each training session, lasting approximately 5 minutes including low-intensity aerobic exercise with stretching and breathing exercises. The stretching exercises involved maintaining a given position for 10 to 15 seconds.

2.4. Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (v20.0, SPSS Inc., Chicago, IL, USA). The results are presented as Mean ± SD. The Kolmogorov-Smirnov test confirmed the normality of the data. The changes in strength and mobility of trunk muscles were compared over the training period for both groups using a two-factor (group × time) univariate analysis of variance (ANOVA). The magnitude of the effect size (ES), represented by the partial Eta squared (η_p^2), was interpreted as: *small* (< 0.01); *medium* (0.01 - 0.14); *large* (> 0.14) (Cohen, 1988). All *p*-values less than 0.05 were considered significant for a 95% probability level.

3. RESULTS

The results obtained on the initial and the final measurements are presented in Table 3. The effects of the Functional training program and Physical Education classes on the strength and mobility of the trunk muscles in primary school girls are presented in Table 4. The F value, statistical significance, and effect sizes were calculated for each test in both groups. A combined analysis of variance (ANOVA) showed that both training methods had a significant effect on muscle strength and mobility in adolescent girls. Both training methods had a *large* positive effect ($p > 0.001$) on abdominal muscle strength, since the partial Eta squared reached .234 and .151. Further, the impact of functional exercises on lower back muscle strength was *large*, whereas the impact of PE classes was found to be *medium*. The improvements in upper body strength were also *large* in the FT group, while a *medium* positive effect was obtained in the PE group. However, a more significant positive effect on thoracic spine mobility was achieved in the PE group compared to the FT group ($\eta_p^2 = .090$ vs. $\eta_p^2 = .190$).

Table 3 Outcome measures, presented as Mean ± SD, for each grade in the Functional Training (FT) group (n = 314) and the Physical Education (PE) group (n = 282).

Measure	5th		6th		7th		8th	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
FT group								
AMS (*n*)	13.58±2.86	18.83±2.93	17.75±4.16	22.72±4.50	20.93±3.39	25.84±3.76	21.47±3.30	27.15±3.13
LBMS (*n*)	17.84±3.32	24.06±3.87	33.98±4.45	40.18±4.91	34.31±9.18	40.45±8.82	34.05±5.79	40.53±6.24
UBS (*n*)	8.08±2.85	13.20±2.90	11.27±4.47	16.04±4.81	12.53±3.39	16.81±3.74	11.98±4.10	16.90±4.07
TSMOB (*cm*)	13.36±2.73	14.93±2.94	19.69±5.65	21.38±6.21	19.89±5.13	21.45±5.40	17.50±3.78	19.48±3.89
PE group								
AMS (*n*)	19.30±3.65	21.52±4.25	19.79±3.62	22.93±3.97	18.08±3.53	19.91±3.93	21.27±4.20	23.60±4.10
LBMS (*n*)	31.69±8.53	34.21±9.04	37.86±5.56	41.24±5.54	32.62±5.75	34.63±6.12	34.13±5.77	36.87±5.85
UBS (*n*)	13.08±4.08	15.25±4.24	14.22±4.37	16.44±4.63	12.32±3.71	13.82±3.53	13.50±2.95	14.85±3.16
TSMOB (*cm*)	23.07±1.54	23.99±1.52	24.32±3.81	25.34±4.33	19.80±3.24	20.41±3.35	16.68±3.64	17.53±3.68

FT - Functional training; PE - Physical Education; AMS - abdominal muscles strength; LBMS - lower back muscles strength; UBS - upper body strength; TSMOB - thoracic spine mobility

Table 4 The effects of training methods on strength and mobility of trunk muscles in primary school girls.

Measure	ANOVA (group × time)			
	F	*Sig.*	η_p^2	*Magnitude*
Functional Training group				
AMS	32.460	> 0.001	.234	large
LBMS	29.688	> 0.001	.219	large
UBS	18.362	> 0.001	.149	large
TSMOB	10.280	> 0.001	.090	medium
Physical Education group				
AMS	16.749	> 0.001	.151	large
LBMS	12.931	> 0.001	.122	medium
UBS	10.701	> 0.001	.103	medium
TSMOB	22.087	> 0.001	.190	large

AMS - abdominal muscles strength; LBMS - lower back muscles strength; UBS - upper body strength; TSMOB - thoracic spine mobility; F - F statistic; Sig. - significance; η_p^2 - partial Eta squared.

4. DISCUSSION

This study investigated the effects of two different training methods on the strength and mobility of trunk muscles in primary school girls. After 16 weeks of the experimental program, significant improvements were observed in both groups. The magnitude of the ES ranged from medium to large, indicating that functional and traditional exercises in PE classes contributed considerably to the development of trunk muscle strength and mobility. However, the impact of training methods mainly differed depending on the muscle groups.

Functional training is a form of physical exercise that is explained by neuronal complexity and higher demands of the central nervous system. The higher the central nervous system demands, the more functional movement is performed (Shaikh & Mondal, 2012). Therefore, the training method is based on complex exercises to prepare the body for everyday challenges, and sports performance (Feito, Heinrich, Butcher, & Poston, 2018). To our knowledge, there is a lack of research regarding functional training and trunk muscles although most complex exercises cannot be performed without activating those muscle groups.

Notwithstanding that the effects of functional training have been examined in various populations, different claims can be found in the existing literature. When the effects of sports training and functional training were investigated, both training methods effectively improved muscle strength and aerobic fitness in overweight boys and girls (Branco et al., 2021). Further, there was no statistically significant difference in maximal isometric strength of the trunk muscles between females who performed functional and traditional training (Da Silva-Grigoletto et al., 2019). Regarding the effects of resistance training, the results of some studies also indicate that functional training is not superior to traditional resistance training in adolescents and adults (Branco et al., 2020; Mcweeny et al., 2020). In addition, it was determined that there was no difference between the two interventions when the effects of functional training were examined in 14-year-old girls with Developmental Coordination Disorder (Bonney et al., 2017).

Contrary to the previous research, there are studies that highlight the advantages of the functional training method over traditional exercises used in PE classes. Namely, performing functional exercises improved movement quality and fitness performance in

primary school girls compared to traditional exercise (Liao et al., 2019). Marković (2015) found functional training to be more effective for the motor development of primary school students compared to PE classes. Further, functional training proved more effective than traditional physical fitness for the daily activities and quality of movement patterns in sedentary older women (de Resende-Neto et al., 2021). In addition to the impact on motor abilities, Bogdani and Pano (2021) pointed out that functional training had a more significant contribution to the reduction of body fat parameters. However, both traditional and functional training produced significant improvements in body composition.

Besides the fact that there is a lack of scientific data regarding functional training and trunk muscles in primary school students, the inconsistency of existing data prevents the generalization and formation of practical guidelines. However, several shortcomings of this study need to be pointed out. The sample consisted of girls who were not involved in any extracurricular physical activities; hence it could be expected that any form of physical activity would contribute to the development of muscle performance. Secondly, the impact of the training methods was investigated only on trunk muscles, although both training methods are known to involve multi-joint exercises, which contribute to the development of these muscle groups. Therefore, it is preferable to compare the effects of the training methods on upper and lower limb muscles. Further, future research should consider comparing the effects of functional and traditional training methods on different motor abilities, such as agility and aerobic endurance. Conclusively, sport-specific examinations are needed in the future, considering that the effects of training methods might differ in girls involved in different sports (e.g., volleyball, tennis), where such data might be useful for the coaching staff.

5. Conclusion

The findings in this study indicate that both training methods can be beneficial for the development of trunk muscle strength and mobility in school-age girls. It can be concluded that functional exercises also represent an adequate tool for improving the abilities of fundamental muscle groups. Therefore, physical education teachers could implement a functional training method in PE classes when the goal is to develop the strength and mobility of the trunk muscles in older female primary school students. To adopt functional training as the primary method in PE classes, additional research is needed.

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FUNKCIONALNI TRENAŽNI PROGRAM I ČASOVI FIZIČKOG VASPITANJA: ANALIZA UTICAJA NA FIZIČKE AKTIVNOSTI UČENICA STARIJIH RAZREDA OSNOVNE ŠKOLE

Cilj ovog istraživanja bio je da se utvrde efekti dva različita programa treninga na snagu i pokretljivosti mišića trupa kod devojčica starijeg školskog uzrasta. Uzorak ispitanika činilo je ukupno 596 devojčica, uzrasta od 11 do 15 godina. Uzorak ispitanika nasumično je podeljen u dve grupe: 1) eksperimentalna grupa (n = 314), koja je sprovodila funkcionalni trenažni (FT) program; 2) kontrolna grupa (n = 282) koja je sprovodila regularne časove fizičkog vaspitanja. Eksperimentalni program sproveden je tokom regularnih časova fizičkog vaspitanja, koji je trajao 16 nedelja. Svake nedelje realizovane su tri trenažne jedinice u trajanju od 45 minuta. Baterija testova FitnessGram korišćena je na inicijalnom i finalnom merenju za procenu snage i pokretljivosti mišića trupa. Korišćeni su testovi za procenu: repetativne snage trbušne muskulature, repetativne snage leđne muskulature, repetativne snage grudnog i ramenog pojasa i pokretljivosti donjeg dela leđne muskulature. Rezultati dvofaktorske analize varijanse pokazali su značajan (p < 0.001) napredak na svim testovima kod obe grupe. Veličina efekta treninga bila je u rasponu od srednjeg do velikog i razlikovala se između protokola na svim testovima, osim na testu za procenu snage trbušne muskulature. Rezultati ovog istraživanja upućuju da su oba trenažna metoda korisna za razvoj snage i pokretljivosti mišića trupa kod devojčica osnovnog školskog uzrasta. Budućim istraživanjima bi trebalo ispitati razlike između metoda treninga kod učenika osnovnih škola.

Ključne reči: *funkcionalni trening, fizičko vaspitanje, osnovna škola, fundamentalni mišići, učenici*