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Pilot Study

What are the Contributions of Daily Physical Education towards Physical Fitness? A Longitudinal Study in Austrian Elementary School Students

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Abstract

Background: In recent years sedentary leisure time habits have been increasing, which has contributed to a decline in physical fitness in children and adolescents. **Aim:** The present pilot study, therefore, examined the effect of daily physical education (PE) on various components of physical fitness in elementary school students. **Materials and Methods:** A total of 28 first grade elementary school students in two separate schools were followed over a period of 3 years (2016 - 2019). The intervention school provided daily PE while the control school continued with 2 hours of PE per week as specified in the curriculum. All participants completed the German motor test, a throwing and agility task at baseline (beginning of grade 1) and follow-up (end of grade 3). **Results:** Children in the intervention group displayed a more pronounced improvement in balance, push-ups, 6-minute run and the stand- and reach test. The improvement in sideways jumping and sit ups, on the other hand, was more pronounced in the control group. Additionally, it was shown that endurance capacity declined in the control group, while the intervention group showed an increase in average distance covered in the 6 minute run. **Conclusion:** Even though some of the observed results can be attributed to catch-up effects due to lower performance at baseline, the results of this 3-year pilot study indicate the potential benefits of daily PE during elementary school years on physical fitness. Particularly the observed decline in endurance capacity during childhood and the possible associated detrimental health effects, emphasizes the need for the promotion of physical activity during the elementary school years.

Keywords: Motor competence; Motor skills; Physical activity; Children; Health

Introduction

Sedentary behavior has been increasing in children and adolescents during leisure time and during school hours [1]. Many teachers also become increasingly concerned about a decline in motor performance and lack of concentration in school children [2-4]. Motor competence, however, is an important aspect in health promotion; it helps people to cope with daily motor tasks and plays a crucial role in overall psychophysical development and general well-being [5-9]. For this reason, medical professionals and sports scientists have emphasized the importance of physical activity (PA) and exercise for general development and various health outcomes [10]. Only a small proportion of children and adolescents, however, meet the current minimum daily requirement of 60 minutes of moderate-to-vigorous PA [11]. Rather, a large amount of leisure time is spent with sedentary pursuits such as watching TV and playing computer games [4,12-15].

When considering daily movement opportunities for children and adolescents, there are three distinctive settings, which are leisure time, organized sport and school. Accordingly interventions targeting an increase in PA need to occur in at least one of these settings. Given the limited control over the social and built environment, schools appear to be a prime target for intervention strategies in which a large amount of children can be reached [16,17]. The Austrian school curriculum, however, only mandates two to three physical education (PE) lessons per week in elementary schools. From an educational, medical and exercise-science point of view this amount is not sufficient to offer the children the amount of PA necessary for health and well-being [18]. Various entities, therefore, have emphasized the importance of daily PE [19], which has been associated with improved motor competence, cognitive performance and overall health [20-24]. Given the limited use of such efforts in Austria, a

pilot project was initiated in the fall of 2016, which implemented daily PE, with annual evaluations, in an elementary school in Tyrol, Austria.

Materials and Methods

This cohort, case-control study examined the influence of daily PE on motor development over a period of three years in Austrian primary school children. Two urban primary schools with comparable socio-ecological conditions were selected for participation. The curriculum mandated two hours of PE in both schools. The intervention school received three additional PE hours per week in order to provide daily PE, while the control school continued with PE twice a week. All PE classes were held by the respective classroom teacher, which is customary in Austrian elementary schools.

Due to the longitudinal nature of the study only students who entered elementary school at the beginning of the study were eligible for participation, which resulted in a sample of 35 first grade students. Of these, 28 children provided valid data at baseline (October 2016) and follow-up (June 2019). All study procedures were approved by the School Board of Tyrol, Austria and the Institutional Review Board of the University of Innsbruck. Parents received written information about the study via the participating schools and provided written informed consent prior to data collection. Students provided oral assent at the time of data collection.

All assessments were performed by trained personal during regular school times in the school's gymnasium. Prior to the physical fitness tests anthropometric measurements were taken. Specifically, body height was measured with a mobile stadiometer (SECA® 217, Seca, Germany) to the nearest 0.1 cm and body weight was measured via a calibrated scale (SECA® 803, Seca, Germany) to the nearest 0.1 kg. Subsequently, body mass index (BMI) was calculated (kg/m²).

Physical fitness was assessed via the German motor test (DMT 6-18) [25], which examines cardiorespiratory endurance, muscular strength, power, speed, agility, balance and flexibility. In addition to individual tests scores the DMT 6-18 also provides an overall motor performance score based on the average of age- and sex-standardized scores across the individual test items (20-m sprint, backwards balance, sideways jumping, stand-and-reach test, standing long jump, sit ups, push-ups, and 6-minute run). Participants also completed a throw-on-target from 3 meters distance against the wall and an obstacle run, which are part of the general motor test (AST 6-11) [26].

Statistical analysis

Descriptive statistics were calculated and interval scaled data are reported as means with standard deviation. Differences in anthropometric characteristics between the intervention and control group at baseline and follow-up were examined via ANOVA. Differences in motor development between the control and intervention school were examined via a 2-way repeated measures ANOVA. Statistical analyses were performed with SPSS 26.0 (Armonk, NY, USA) and the significance level was set at $p \leq 0.05$.

Results

A total of 12 children (58.3% male) in the intervention group and 16 children (56.3% male) in the control group provided valid data at both measurement times. There were no significant differences in anthropometric characteristics between the intervention and control group at baseline and follow-up (Table 1).

	Baseline (2016)		Follow up (2019)	
	Intervention	**Control**	**Intervention**	**Control**
Age (years)	6.2 ± 0.4	6.5 ± 0.6	8.7 ± 0.5	8.9 ± 0.0
Height (cm)	122.1 ± 5.3	123.8 ± 4.9	136.9 ± 5.9	138.9 ± 6.1
Weight (kg)	23.9 ± 3.3	26.2 ± 7.1	34.7± 5.7	36.8 ±10.2
BMI (kg/m^2)	15.9 ± 1.6	16.9 ± 3.2	18.5 ± 2.3	18.9 ± 3.9

Values are mean ± SD

Table 1: Anthropometric characteristcs of the study population at baseline and follow-up.

Across the entire study population there was a significant improvement in performance on sprint, balance, sideways jumping, push ups, sit ups, standing long jump, obstacle run and throw and catch. No significant improvement was observed in the 6 minute run and the stand and reach test. Significant time by intervention effects were observed for balance, sideways jumping, push-ups, sit ups, 6-minute run and stand-and-reach test (Table 2).

Specifically, the intervention was associated with a more pronounced improvement in balance, push-ups, 6-minute run and the stand- and reach test. In fact, average performance decreased in the 6-minute run and the stand- and reach test in the control group while the intervention group showed an improvement in average performance on these tests. The more pronounced improvement in push-ups in the intervention group may be attributed to the lower baseline performance and a possible catch-up in upper body strength. Baseline performances, on the other hand, was lower for sideways jumping and sit ups in the control group, with a catch up until follow-up assessment that contributed to significant interaction effects and a more pronounced improvement in these components in children of the control group.

	Group	Baseline–(2016)	Follow up (2019)	*p* for Interaction
20-m sprint (sec)*	IG	4.7 ± 0.5	4.2 ± 0.8	0.473
	CG	4.7 ± 0.8	4.4 ± 0.5	
Balance (steps)*	IG	22.8 ± 9.3	41.2 ± 5.9	**0.013**
	CG	19.6 ± 8.3	29.4 ± 12.1	
side jumps (# in 15 sec)*	IG	31.8 ± 6.1	41.9 ± 5.2	**0.001**
	CG	22.2 ± 6.5	40.0 ± 6.6	
Stand-Reach (cm)	IG	1.3 ± 9.1	6.6 ± 7.7	**<0.001**
	CG	3.3 ± 4.6	-0.7 ± 7.9	
Push-ups (# in 40 sec)*	IG	11.0 ± 3.3	16.3 ± 4.2	**0.005**
	CG	20.0 ± 5.1	19.6 ± 4.4	
sit ups (# in 40 sec)*	IG	15.8 ± 5.5	21.3 ± 7.1	**0.004**
	CG	8.4 ± 5.5	20.4 ± 5.9	
Long jump (cm)*	IG	121.6 ± 19.8	131.8 ± 14.9	0.193
	CG	110.8 ± 23.0	129.1 ± 21.1	
6-min run (m)	IG	860.3 ± 121.2	908.2 ± 120.2	**0.003**
	CG	851.7 ± 169.7	747.7 ± 99.4	
Throw on Target (n)	IG	9.13 ± 3.29	11.93 ± 3.65	0.247
	CG	6.88 ± 3.59	11.41 ± 4.08	
Obstacle run (sec)	IG	23.40 ± 4.99	19.38 ± 3.01	0.212
	CG	26.56 ± 11.31	20.12 ± 5.73	

Values are mean ± SD; *****sig. Effect for time ($p \leq 0.01$)

Table 2: Motor performance at baseline and follow-up separately for intervention group (IG) and control group (CG).

Discussion

This 3-year, longitudinal study evaluated the effect of daily PE on motor performance in elementary school students. As expected motor performance generally improved during the elementary school years. Only the performance on the endurance and flexibility tests remained stable throughout the observation period. The intervention, however, was associated with an improvement in these components, while average performance declined in the control group. Further, beneficial effects of daily PE could be shown for balance and upper body strength. The more pronounced improvement in upper body strength, however, may also be attributed to a catch-up effect as participants in the intervention performed worse than the control group at the baseline measurement. The same may be true for the more pronounced improvement for sit ups and sideways jumping in the control group as this group showed lower performance at baseline compared to the intervention group. The results of this study, therefore, only partially support the previously reported beneficial effects of daily PE compared to PE twice a week [16,20-22,27,28].

Despite the limited significant intervention effects shown in this study, the results shown for endurance capacity, however, warrant additional attention. Given the importance of endurance capacity on cardiovascular health [2], it is of concern that children in elementary school are not able to improve endurance performance despite their continued growth and maturation. In fact, the results of this study show already a potential decline without additional organized exercise time. The importance of endurance capacity in the reduction of cardiovascular disease risk has been emphasized in several studies [9,29,30]. Further, Hasselstrom et al. [31] showed that cardiovascular risk factors often have their origins in childhood and continue to worsen into adulthood. Accordingly, various exercises that promote the development of cardio-respiratory endurance should be provided already at young ages and PE should be considered a viable option for the establishment of an active and healthy lifestyle.

Strengths and Limitations

The limited effects of daily PE in other components on physical fitness may also be attributed to the small sample size. In addition, it should be considered that there was no information on leisure-time activities. Children in the control group, therefore, could have engaged in various forms of physical activity, including sports during leisure-time that may have contributed to a similar motor development. Children in the intervention group, on the other hand, may have compensated for their higher PA time during school hours. Further, it was intended to follow the study participants over their entire elementary school time. Due to the current restrictions with the COVID-19 pandemic, it is, however, not possible to assess participating children in their fourth year, which would mark the end of elementary school. The shorter observation period may also have contributed to limited intervention effects of the study. The longitudinal design with objective assessments of various components of physical fitness and motor competence, however, remain a strength of this study.

Conclusions

In summary, the results of the present study indicate the potential of daily PE for the promotion of physical fitness and motor competence. Given the lack of improvement and possible decline in endurance capacity already at young ages

additional efforts to ensure sufficient stimuli for an adequate development of endurance capacity already during the elementary school years are warranted. Schools provide a viable intervention setting as most children independent of socio-economic status can be reached. Given the limited amount of time children spend in schools, additional strategies including parents and sports clubs, however, need to be included as well.

Disclosure

No relevant financial affiliations

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