

Changes in strength abilities of adolescent girls: the effect of a 3-year physical education curriculum

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Summary

Study aim: To evaluate changes in strength abilities of adolescent girls that underwent a 3-year physical education curriculum.

Material and methods: The research participants comprised 141 girls aged 13.3 ± 0.35 years who participated in a 3-year physical education curriculum (PEC). Evaluation was based on the following EUROFIT Testing Battery tests: standing broad jump, handgrip strength, sit-ups, and bent arm hang. After the completion of the curriculum, changes in strength abilities of the participants were evaluated. Test results were compared to reference values for the population of Polish girls.

Results: After the 3-year PEC, research participants obtained significantly better results in all analyzed tests. At the beginning of the PEC, participants performed significantly worse in comparison to the reference values for the standing broad jump and bent arm hang tests, and better in the handgrip strength test. After the completion of the PEC, the participants performed significantly better in the sit-up and handgrip strength tests compared to reference values; for the standing broad jump and bent arm hang tests, they performed closer to the reference values.

Conclusions: While the development of student physical fitness is achievable through physical education lessons at school, innovative teaching methods and professional and creative approaches on the part of teachers are necessary.

Key words: Strength abilities – Physical education curriculum – Girls

Introduction

Proper physical fitness, which determines healthy development of adolescent girls, can be achieved through regular physical activity of adequate intensity and duration. According to the 2008 guidelines of the European Commission [16], school-aged youth should participate in moderate to vigorous daily physical activity for 60 minutes or more. However, many researchers [5,7,8,13] have found that moderate and vigorous physical activity constitutes about 47% of physical education lesson time in primary schools and 40% in secondary schools. Studies also indicate that the effective time of physical activity for girls has significantly decreased in high school. Research done by Nader [10] has shown that actual effective time of student physical activity during a 45-minute physical education lesson is about 25 minutes. Moreover, Dudley *et al.* [5] have found that girls spend about 31% of the lesson sitting. This means that during a physical education lesson, the average intensity of student physical activity corresponds to the “sustaining effort,” which does not develop motor skills [10]. National tests of children and youth conducted every 10 years also indicate a low effec-

tiveness of physical education at schools. The test from 1999 showed a significant drop in physical activity performance compared to the results from 20 years ago [11]. These data are disturbing, since the physical fitness of an adult largely depends on his or her upbringing and development during childhood and youth. Therefore, values acquired during childhood will determine lifestyle well into old age [1].

With the aforementioned deficiencies of scholastic physical education in mind, a special physical education curriculum (PEC) for high schools was created. The curriculum was implemented between 2007 and 2010 in 4 state high schools in Łowicz, Łódzkie Province. The curriculum only included girls, because studies have shown that adolescent girls have a much lower need for physical activity than adolescent boys [10,13]. The aim of the PEC was to develop independence in girls and encourage them to take on additional physical activity apart from school lessons. This paper focuses on evaluating changes in strength abilities of adolescent girls undergoing the PEC. The development of strength abilities is especially intense during adolescence. At the same time, changes in the maturing body (a rapid gain of body weight and changes in

body proportions) make it difficult for girls to engage in physical activities that require overcoming own body, i.e., the activities that are used to develop strength abilities [17]. Thus, the aim of the study was to assess changes in strength abilities of adolescent girls that underwent a 3-year physical education curriculum.

Material and Methods

Research participants comprised 141 girls aged 13.3 ± 0.35 years undergoing a 3-year physical education curriculum (PEC). It was assumed that in each successive year, girls undergoing the PEC would personally engage in an increasingly wider scope of duties related to conducting a physical education lesson. Initially, the participants conducted only selected exercises or short sections of a lesson, whereas in the final stage of the PEC, participants designed and conducted a whole lesson under a teacher's supervision. Proper implementation of the PEC and the achievement of expected results required appropriate supervision on the part of teachers. Therefore, all teachers (members of the project development team) conducted a sample lesson that was observed and later discussed by the author of the project and other teachers involved in the PEC.

Participants' strength abilities were evaluated based on 4 strength tests of the EUROFIT Testing Battery [4]: SBJ (standing broad jump), HGR (handgrip strength), SUP (sit-ups), and BAH (bent arm hang). The tests were conducted at the beginning of the PEC (October 2007) and following its completion (May 2010). In addition, the participants underwent basic anthropometric measurements, i.e., the measurement of body height, body mass, from these the BMI values were calculated.

Due to considerable discrepancies between empirical distribution and normal distribution, body mass and BAH values underwent logarithmic and square root transformation, respectively. HGR results were analyzed using relative values, i.e., in relation to participants' body mass. To compare the obtained results against reference values for the Polish population, the participants' anthropometric parameters and the results of the participants' strength tests were normalized against the functions of mean and standard deviation for age computed for the sample of Polish girls [14]. The body height and body mass proportions of research participants were compared to percentile ranks for standard body mass, body height, and to BMI for girls with a normal amounts of fat tissue [15]. The significance of changes for the mean values of the analyzed parameters after the completion of the PEC was assessed using Student's t-test for paired samples. The differences between mean values for the participants and for the ref-

erence sample were evaluated using Student's t-test for independent samples. The level of $\alpha = 0.05$ was considered significant.

Results

Table 1 presents the mean values (\pm SD) of participants' somatic parameters and strength test results recorded before and after the PEC. Research participants were considerably taller and heavier than girls in the reference sample ($p < 0.001$), both before and after the PEC. Furthermore, participants' BMI values exceeded the reference values by 0.89 SD ($p < 0.001$) at the beginning of the PEC and by 0.66 SD ($p < 0.05$) following its completion.

Table 1. Mean (\pm SD) values of somatic and strength variables recorded in girls ($n=141$) before and after 3-year physical education curriculum

Variable	Before	After
Body height (cm)	160.3 ± 6.4	$165.7 \pm 5.6^{***}$
Body mass (kg)	51.6 ± 11.6	$58.0 \pm 11.9^{***}$
Body mass index	20.0 ± 3.8	$21.1 \pm 3.8^{***}$
SBJ (cm)	154.5 ± 21.6	$165.6 \pm 23.5^{***}$
HGR (kg)	27.4 ± 5.4	$28.9 \pm 5.2^{***}$
SUP(n)	22.0 ± 4.3	$25.0 \pm 4.2^{***}$
BAH (s)	6.9 ± 8.7	$8.3 \pm 11.1^*$

Legend: SBJ - Standing broad jump; HGR - Handgrip strength; SUP - Sit-ups; BAH - Bent arm hang; Significantly different from the *Before* value: * $p < 0.05$; *** $p < 0.001$

A comparison of the participants' performance during strength abilities tests before and after the PEC showed that participants performed considerably better in all the conducted tests after participating in the PEC for 3 years. The greatest and most significant ($p < 0.001$) increase (approximately 20%) in the results was observed for the bent arm hang test, although the average time of hanging remained relatively short (8.3 s), and the results varied greatly between participants. In the sit-up test, participants improved performance by an average of 3 sit-ups (from 22 to 25 sit-ups). The improvement in the standing broad jump and handgrip tests was relatively lower, though statistically significant ($p < 0.001$), corresponding to around 7% and 5% of the initial values, respectively.

Figure 1 shows the average results of fitness tests compared to reference values for the population of Polish girls. At the beginning of the PEC, the girls performed considerably worse in the standing broad jump and bent arm hang tests (by approximately 0.25 and 0.45 SD, respectively), but performed significantly better (by approximately 0.95 SD, $p < 0.001$) in the handgrip strength test,

compared to the reference sample. After 3 years of the PEC, the girls performed significantly better ($p < 0.001$) in the sit-up and handgrip strength tests compared to the reference sample, and performed closer to the reference sample in the standing broad jump and bent arm hang tests (by approximately 0.09 and 0.35 SD, respectively).

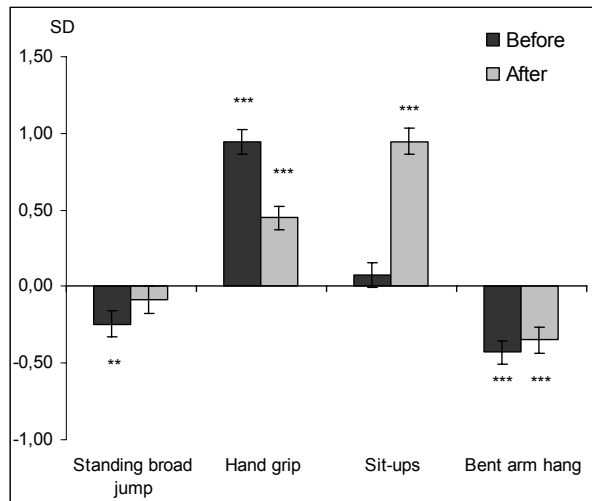


Fig. 1. Mean (\pm SE) values of fitness variables recorded in studied girls ($n=141$) before and after 3-year physical education curriculum standardized against functions of mean and standard deviations for age calculated for girls from Polish population [14] (horizontal line = 0)

Significantly different from the girls from Polish population: ** $p < 0.01$; *** $p < 0.001$

Discussion

This paper focused on evaluating changes in strength abilities of adolescent girls who underwent a 3-year physical education curriculum (PEC). Analysis of the obtained results showed that girls who underwent the PEC improved their strength abilities. The observed changes took place in all the analyzed fitness tests, with the greatest improvement taking place in the bent arm hang test. However, it must be taken into account that the observed changes, in addition to the effects of the PEC, may have been enhanced by the subject's ongoing physical development and strength-ability development, since both of these developments are especially intense during adolescence. Nevertheless, the PEC's effectiveness was supported by the decrease in the difference between the performance of the participants and the performance of the reference sample. It should be assumed, therefore, that the observed changes in participants' strength abilities can primarily be attributed to the implementation of the PEC. The observed reduction of the difference in BMI values between the subjects and the reference samples may also constitute a positive effect of the PEC. Similar results have been

obtained by Chiodera *et al.* [3], who, after implementing their PEC in primary schools, observed positive changes in participants' physical fitness, but did not observe changes in BMI values despite a general-population tendency for body mass gain. In addition, Gutin *et al.* [6], after a year-long FitKid fitness curriculum for younger school-age children, observed improvement in both physical fitness parameters and body composition parameters. However, after the holiday period, the values of these parameters dropped to the levels observed for non-participating children. The above findings suggest that even innovative physical education curricula are not enough to guarantee the proper development of physical fitness, meaning that children and adolescents should be physically active not just at school, but during their spare time as well. That is why such curricula should include the promotion of a healthy lifestyle.

Positive results coming from the PEC may have been realized because participating teachers were able to systematically improve their teaching methodology during the 3 years the curriculum was implemented. To this end, monthly meetings were organized during which the participating teachers not only familiarized themselves with the aims of the PEC and its methods of implementation, but also presented their achievements and discussed the results their students. The meetings allowed for an ongoing assessment of the PEC and provided means for homogenizing the methods used by participating teachers. The relationship between a teacher's level of vocational competence and the effects of their work with children and adolescents is further confirmed by the findings of other researchers who implemented innovative solutions and physical education curricula, both in Poland and in other countries. For instance, Sallis *et al.* [12], observed a relationship between the physical fitness of 9-year-old students and the competence of teachers implementing the SPARK curriculum, i.e., specialized teachers, teachers trained to conduct physical education lessons, and untrained teachers working with students in kindergarten through third grade. Positive effects were observed for physical fitness tests (abdominal muscle strength and endurance) in groups of children under the supervision of teachers with the highest qualifications. Additionally, these groups made much more efficient use of lesson time through an increased amount of time spent on moderate and vigorous physical activity. Similar observations have been made by McKenzie *et al.* [9], who concluded that the effectiveness of the standard physical education curriculum in schools depends largely on teacher qualifications and on the location where the lesson takes place. Therefore, professional physical development curricula should be adjusted to local needs and conditions.

The improvement of participants' strength abilities could also have been affected by the teachers' use of the "improve your last score" method for assessing participant fitness. According to Przewęda and Dobosz [11], the level of motivation is 1 of 3 factors (next to constitution and motor abilities) that affect physical fitness, as assessed by outdoor fitness tests. The implementation of the above method motivated the girls to work on their physical fitness and to perform better and better during tests.

The effects of the 3-year PEC show that the development of motor abilities in adolescent girls can be effectively shaped by physical education lessons at school. This requires a specially designed curriculum and evaluation method. The evaluation method should motivate students to undertake physical activity beyond physical education lessons at school. Also important is to support teachers by systematically analyzing their work and directing it. This is substantiated by the experience of other researchers implementing innovative solutions and physical education curricula [2,3,6,8,12]. Their experience shows that taking part in physical education lessons that are appropriately designed and conducted unconventionally stimulates a child's physical development, facilitates the acquisition of new motor abilities, and creates a habit of regular physical activity that will last into adulthood. To summarize the research results: the 3-year PEC seems more efficient at improving strength abilities and physical development of girls. It can also be concluded that despite a low effectiveness of physical education lessons, the development of student physical fitness is achievable within the confines of physical education at schools; however, this requires using innovative teaching methods and a professional and creative approach to the subject on the teacher's part.

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