Scand J Med Sci Sports 2007
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DOI: 10.1111/j.1600-0838.2007.00682.x

SCANDINAVIAN JOURNAL OF
MEDICINE & SCIENCE
IN SPORTS

Specifically designed physical exercise programs improve children's motor abilities

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Accepted for publication 1 March 2007

Physical activity in schools is declining in many countries and inactivity in childhood has become a recognized risk factor. Data from a program of professionally guided physical exercise in primary school children were collected before and after the academic year of training. Four thousand five hundred children (6–10 years) were enrolled, and conditional and coordinative motor abilities (speed, trunk flexibility, long jumping, somersault, Harre circuit test) were measured. Anthropometric measurements were focused on body mass index (BMI), weight and height. Females never showed a significant variation of BMI, whereas males in the first and fourth grades showed significant differences. On the contrary, when considering the motor abilities studied, all the comparisons were highly significant. At the end of training, both males and females did better than at the beginning, and males were constantly faster than females. Our data, generated on a large number of children, show that professionally guided programs of physical education in the primary school lead to significant progresses in the development of conditional and coordinative abilities, without altering BMI values, thus not interfering with the balanced progression of body weight and height.

It is now well established that several chronic diseases typical of westernized countries, such as diabetes, cardiovascular diseases and hypertension, can be observed in children in frequent association with obesity (Must & Strauss, 1999; Bouchard, 2000; Sothern & Gordon, 2003). Similarly, no doubt exists about the causal link between the decline in habitual physical activity that characterizes western world lifestyle and health. In a recent review, Dollman et al. summarized available trend data on physical activity, together with indirect measurements of sedentariness, fitness and attitudes, concluding that physical activity in defined contexts, such as school physical education and organized sports, is declining in many countries (Dollman et al., 2005). Various surveys and research studies have expressed a general consensus on the preventive role of regular physical exercise associated with a correct and adequate diet (Must & Strauss, 1999; Bouchard, 2000; Sothern & Gordon, 2003). A sedentary style of life is the common etiopathogenetic basis of "paramorphism" of the different organs and systems, which generates the hypokinetic syndrome.

A positive relationship between physical activity and aerobic fitness has been established in adults (Blair et al., 1989; Young & Steinhardt, 1993; Andersen & Haraldsdottir, 1995; Shephard & Trudeau, 2000; Ball & McCargar, 2003; Malina et al., 2004; Andersen et al., 2005). On the contrary, a relationship between the activity levels of children, their aerobic fitness and their level of fatness has only recently been demonstrated (Rowlands et al., 1999), essentially because it is still unclear as to which aspects of physical activity are relevant in regulating body weight (Must & Strauss, 1999; Bouchard, 2000; Sothern & Gordon, 2003). Results, however, show that inactivity in childhood is related to increased levels of body fat. Inactivity is certainly only one of the factors linked with obesity, but it is perhaps the easiest to modify. Body fatness and low physical

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(Table 1) (three lessons per week for a total of 99 lessons in the study period), focused on the development of the following motor abilities (both conditional and coordinative): (i) speed; (ii) trunk flexibility; (iii) long jumping; (iv) somersault (first and second grades); and (v) Harre circuit test (third, fourth and fifth grades). It was also explained to the children parents that both BMI and motor abilities would have been monitored twice each academic year: in October (beginning) and in May (end) of the year's program.

Anthropometric measurements

Anthropometric measurements were focused on BMI, calculated as body weight divided by squared height (kg/m^2) (Rolland-Cachera et al., 1982). Measurements were made on a total of 4177 children (2041 females and 2136 males). All measurements were made by two independent qualified technicians. Body weight and height (without shoes) were measured wearing minimal clothing to the nearest 0.1 kg and 0.1 cm, respectively. Measurements were obtained in the morning, with no instructions about voiding. When the values obtained from the independently repeated measurements differed by >2%, the data were excluded from the statistical analysis. The equipment used for measuring height and weight were the same for every measurement. Overweight was defined as BMI >25.

Conditional abilities (speed and trunk flexibility)

Speed was measured on a total of 4325 children (2118 females and 2207 males). Children were asked to run 20 m at maximum speed. Time was measured electronically to the nearest 0.01 s.

Trunk flexibility was measured on a total of 4244 children (2074 females and 2170 males). After a 3-min warm-up, children were asked to sit on the measurement device outlined in Fig. 1(a). During the test, an operator checked the complete extension of the knees. The measurement table was adjusted so that the tip of the feet corresponded to 0. Beyond that point, values were positive; before that point, values were negative. All values were expressed in centimeters.

Coordinative abilities (long jumping, somersalt and Harre circuit test)

Long jumping was measured on a total of 4253 children (2079 females and 2174 males). Children were asked to jump horizontally without the classical approach run. During the jump, arms were projected upwards. Children must land standing on both feet.

Somersault was assessed on a total of 1820 children from only the first and second grades (884 females and 936 males). The test was supervised by two technicians who attributed a score (1–3) to the ability of the child as follows:

1 = wrong execution of the test;
2 = the test is performed correctly, but hands are put down to help in the final phase; and
3 = the test is performed correctly.

A total of 1902 children from the third, fourth and fifth grades (929 females and 973 males) were tested with the Harre test (Harre, 1982). Children were asked to complete the circuit outlined in Fig. 1(b) at maximum speed. Final time was measured electronically to the nearest 0.01 s. The execution of the test required an initial somersault and three consecutive passages above and underneath three obstacles. Near each

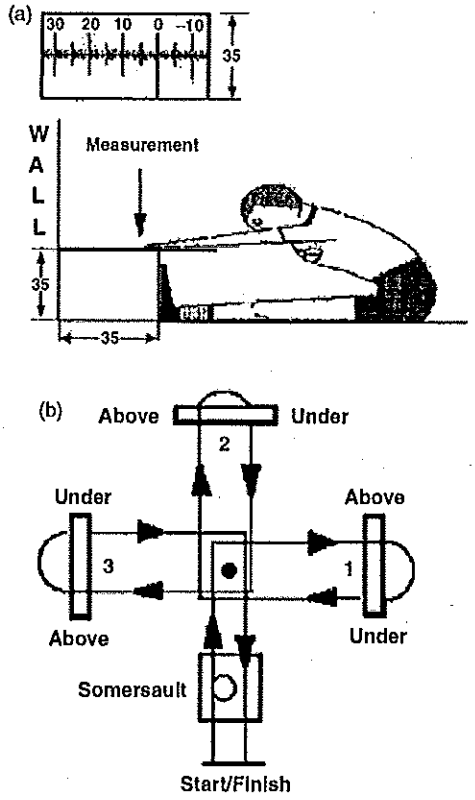

Fig. 1. Flexibility measurement method and scheme of the Harre circuit.

obstacle, a technician monitored the performance of the subject. If the subjects made a mistake (e.g. touching the obstacle), the test was repeated once. In case of a second mistake, the test was considered unsuccessful.

Statistics

The analysis was carried out separately for each school grade (first, second, third, fourth and fifth) and for boys and girls. Means and standard deviations were calculated both for the total number of children and for males and females separately.

Data were analyzed:

(a) To compare male and female performances at the beginning and at the end of the school year, by using a *t*-test for independent groups.
(b) To measure the variations in the different parameters from October to May, by using a *t*-test for dependent groups.

The analysis was performed using the SPSS statistical package.

To compare male and female performances at the beginning and the end of the school year, we applied the *t*-test procedure for the difference between two means for independent samples. In this study, in fact, males and females were sampled independently. Results show whether there is any difference in the mean performances of males and females.

To measure the variations of each single parameter from October to May under professional training, the paired-sampled *t*-test procedure had been used. In this case, the samples are, of course, dependent because they represent before-and-after observations on the same subjects.

Data were considered significant for $P<0.05$.