Effect of extra physical education upon physical development

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Investigation into the Effects of Two Extra Physical Education Lessons per Week during one School Year upon the Physical Development of 12- and 13-Year-Old Boys[1]

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Introduction

The reason why this investigation has been set up was the wish, repeatedly expressed by Dutch education authorities, to increase the number of weekly lessons in physical education (p-e) in schools from 3 to 5. In the Proposed Curriculum for the Government Schools [1968], one finds the aims of p-e expressed as follows: (1) to produce a favorable influence on development of the body; (2) to promote good bearing and stature; (3) to increase the willingness and ability to participate in physical activity; (4) to stimulate teamwork; (5) to form good health habits; (6) to become acquainted with valuable forms of active recreation for one's leisure time.

In a pilot study, the influence was studied of 5 p-e lessons per week compared with 3 lessons per week in the course of a whole school year upon the physiological and psychological characteristics of 12- and 13-year-old schoolboys [KEMPER, 1973]. The results did not suggest that there was any clear improvement in physical development. Physical skill levels, however, became increasingly higher in the experimental class.

In order to retest the results of this pilot study, it was decided to replicate the former experiment.

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Methods

Subjects were boys of the 4 first forms of a secondary school in Amsterdam, St. Ignatius College. From 82 boys, 12 dropped out. At the beginning of the school year 1971/1972, their mean chronological age was 12.5 (± 0.4) years. Each class had its own teacher of p-e, who was also the mentor of that class. Two classes were assigned by lot as experimental and two classes as control group.

The independent variable was the frequency of lessons per week in p-e. Duration, intensity and content were held constant. The usual number of 3 lessons of p-e a week were given to the control group and 5 lessons of p-e a week to the experimental group. The 2 extra lessons of physical education had been added to the timetable in such a way that the experimental group received a total of 34 instead of 32 lessons week.

At the beginning (pretest) and at the end of the school year (posttest), the following groups of dependent variables were measured in a pretest-posttest control group design.

1. Anthropometric Variables, Measuring Body Build and Body Composition

Height, weight, and circumference, breadth and skinfold measurements were taken to evaluate the influence on skeletal, fat and muscle mass. The weight-for-height relationship in these subjects was compared with Dutch boys [VAN WIERINGEN *et al.*, 1968]. Values lay within the normal range, between the 10th and 90th percentile (fig. 1).

2. Physiological Variables

Aerobic power, measured as physical working capacity (W_{170}) [WAHLUND, 1948], was determined on a bicycle ergometer (fig. 2).

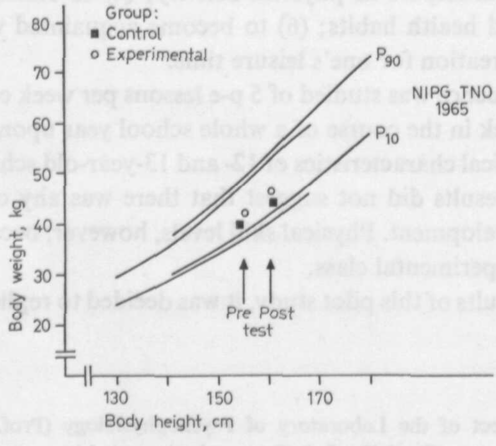

Fig. 1. Comparison of weight-for-height relation in Dutch boys (1965) with our subjects.

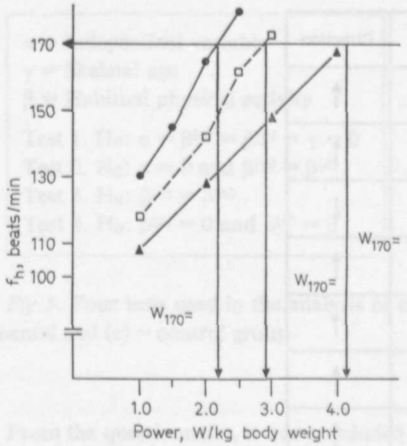

Fig. 2. Determination of W_{170} on bicycle ergometer test in 3 subjects.

The exercise test consisted of 4 load periods of 3 min each. The load was related to body weight. All subjects started with a load of 1.0 W/kg body weight. Each successive period the load was increased. The increase in load was determined on the basis of the heart rate reached in the last minute of the preceding load period (fig. 3).

For the evaluation of other aspects of the physical performance, simple performance tests were employed. The choice of the tests was based on the results of the only study that applied factor analysis to test scores of boys of the same age [Simons *et al.*, 1970]. Measures included: explosive arm strength (handgrip), explosive leg strength (vertical jump), muscular endurance (bent arm hang), flexibility (sit and reach), speed of arm movement (plate tapping), running speed (50-meter shuttle run) and aerobic power (12-min run-walk test).

The ventilation performance was measured as FEV%.

Period	Time	Intensity							
1	3 min	1.0 W/kg							
		Choice of following loads depends on mean heart rate (f_h) in the last minute of the preceding load:							
		$f_h \geq 120$				$f_h < 120$			
2	3 min	1.5 W/kg				2.0 W/kg			
		$f_h \geq 140$		$f_h < 140$		$f_h \geq 140$		$f_h < 140$	
3	3 min	2.0 W/kg		2.5 W/kg		2.5 W/kg		3.0 W/kg	
		$f_h \geq 160$	$f_h < 160$	$f_h \geq 160$	$f_h < 160$	$f_h \geq 160$	$f_h < 160$	$f_h \geq 160$	$f_h < 160$
4	3 min	2.5 W/kg	3.0 W/kg	3.0 W/kg	3.5 W/kg	3.0 W/kg	3.5 W/kg	3.5 W/kg	4.0 W/kg

Fig. 3. Procedure of the loading pattern on the bicycle ergometer.

No.	Factor	Representative variable	Direction
1	Ventilation	FEV %	↑
2	Muscle mass	corr. upper arm diam.	↑
3	Fat mass	fat %	↓
4	Speed of limbs	plate tapping	↑
5	Running speed	50-meter shuttle run	↑
6	Muscular endurance	bent arm hang	↑
7	Explosive arm strength	hand grip	↑
8	Aerobic power	W_{170}	↑
9	Perform. in phys. educ.	score skill tests	↑

Fig.4. Definitive hypotheses. Arrows indicate in which direction the effect will be expected.

3. Skill Variables, Measuring Progress in Performance of Physical Education in a Narrower Sense

Objective performance tests were developed to measure progress in skills. Every test was scored on a 5-point scale. A total of 31 tests was used. To obtain an impression of the progress, the school year was divided into 4 periods. The sum of the scores on the skill tests was considered as the school grade in p-e for that period (fig. 7).

Based upon a review of the literature [KEMPER *et al.*, 1974], 9 hypotheses were formulated about the effect of the independent variable upon the dependent variables (fig. 4). The arrows indicate in which direction the effect was expected.

Although an increase from 3 to 5 lessons a week seemed sufficient to find effects of extra lessons of p-e, there may have been interfering variables that could mask these possible effects.

The following were considered to be potential interfering variables: (1) biological age, measured on pretest as skeletal age by X-ray photography of hand and wrist; (2) habitual physical activity, measured by pedometers and a questionnaire.

On pretest, the range of skeletal age, averaging 12.8 years ($\pm$ 0.8) was 3.1 years. On pretest, the range of chronological age, averaging 12.5 years ($\pm$ 0.4), was 1.8 year. Thus, the range of the skeletal age of these pupils was two times the range of chronological age.

With pedometers attached to the waist of the subjects, information about the amount of physical activity of the boys during leisure time was gathered. From the pedometer scores, remarkable interindividual differences in habitual physical activity could be demonstrated. In some periods, these differences were 6, 7 or even 10-fold.

α = Independent variable
γ = Skeletal age
β = Habitual physical activity

Test 1. H_0: $\alpha = \beta^{(e)} = \beta^{(c)} = \gamma = 0$
Test 2. H_0: $\alpha = 0$ and $\beta^{(e)} = \beta^{(c)}$
Test 3. H_0: $\beta^{(e)} = \beta^{(c)}$
Test 4. H_0: $\beta^{(e)} = 0$ and $\beta^{(c)} = 0$

Fig. 5. Four tests used in the analysis of covariance. H_0 = Null hypothesis. (e) = experimental and (c) = control group.

From the questionnaire, it was concluded that 30.8% of the total time was spent for transportation, 16.1% for organized activities and 53.1% for all other activities during leisure time.

The systematic differences between experimental and control group were analyzed by the following statistical steps: (a) The dependent variables were divided into groups that were supposed to be more or less independent from each other. (b) The grouped pre-test data were factor-analyzed for both experimental and control group. Further, the representative variables found in both groups were used to formulate the hypotheses (fig. 4). (c) For each of the hypotheses, the mean difference scores of experimental and control group were compared by way of analysis of covariance, while making allowance for the influence of the independent variable (α), the habitual physical activity (β), the skeletal age (γ), and interaction of α and β (fig. 5).

Four tests were applied. If test 1 is significant, there is a difference between experimental and control group caused either by the extra lessons (α), habitual physical activity (β), or biological age (γ). If test 3 is not significant, it can be said that the difference between experimental and control group is caused only by the additional physical education. Test 4 looks for an effect of habitual physical activity identical for both groups. Tests 2–4 were also done for biological age.

Results

The 8 hypotheses, tested by analysis of covariance, did reveal that the explosive arm strength (measured by handgrip) proved to increase significantly ($p \leq 0.01$) in the experimental group relative to the control group (fig. 6).

Series of skill tests were used to evaluate the performance in p-e in a narrower sense at four points during the year. Analysis of these data showed a significantly higher score ($p \leq 0.009$) of the experimental group compared to the control group (fig. 7).

Variables	Test 1	Test 2	Test 3	Test 4
FEV%	n.s.			
Corr. upp. arm diam.	*	n.s.		n.s.
Fat, %	n.s.			
Plate tapping	n.s.			
50-meter shuttle run	n.s.			
Bent arm hang	n.s.			
Handgrip	**	**	n.s.	n.s.
W_{170}	n.s.			

n.s. = Not significant; * $p \leq 0.05$; ** $p \leq 0.01$.

Fig. 6. Results of the analysis of covariance. Tests correspond with figure 5.

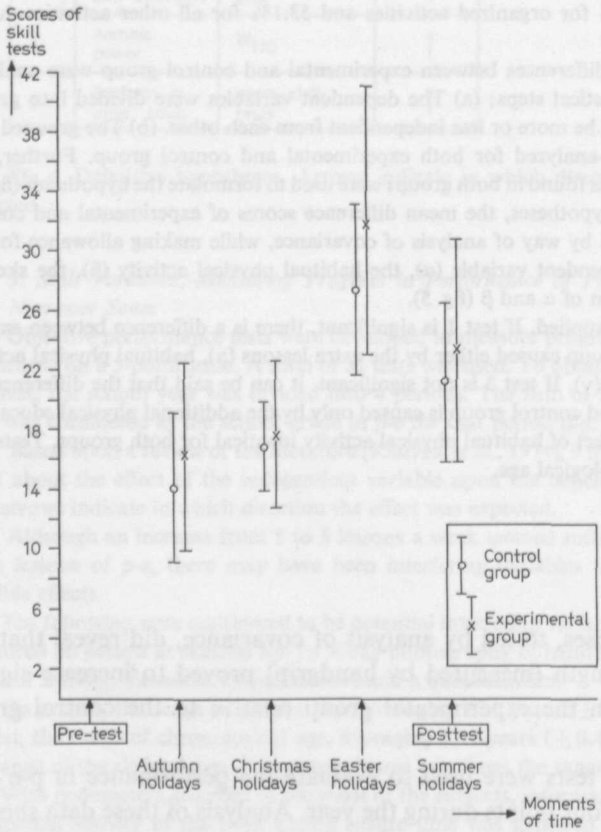

Fig. 7. Mean and standard deviation of scores of skill tests of experimental and control group (ordinate) and periods of measurement (abscissa).

Discussion

Although only the effect of extra lessons in p-e was hypothesized, the influence of habitual physical activity and biological age were also analyzed.

(a) Besides the effect of the extra lessons upon the explosive arm strength (handgrip), an influence of biological age, identical for both groups, could be demonstrated ($p \leq 0.05$). Habitual physical activity had no influence.

(b) Upon the variable corrected upper-arm diameter, a significant effect could be proved in the experimental group ($p \leq 0.05$) caused either by the extra lessons in p-e and/or habitual physical activity and/or biological age. Further analysis revealed that a small, but insignificant ($p < 0.10$) influence of biological age alone is present. Influence of habitual physical activity could not be demonstrated ($p \leq 0.05$). Thus, the difference found in test 1 may be caused by a combined influence of biological age, additional p-e, habitual physical activity and other unknown factors.

Conclusion

In general, it can be stated that the expectations about the effects of two extra lessons of physical education upon 12- and 13-year-old boys could not be confirmed.

In a five versus three lessons a week physical education program, significant increases in p-e skills were found in the experimental group. However, among the other 8 hypotheses, a significant increase in only explosive arm strength could be shown in the experimental group with regard to the control group.

It must be stressed that these results do not have any implication for the evaluation of the regular curriculum of physical education.

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Work Capacity, Strength, and Body Measurements of Adolescent Boys in a Special Sports Program Compared to Normal Boys: Initial Comparison

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In 1972, new curricula were introduced in special schools in Belgium to provide opportunities for in depth instruction in areas such as art, engineering, and sports.

In three schools specially qualified personnel and equipment were provided to conduct the sports program. One of the schools was located in a suburban district of Brussels (Wemmel). The program, applied to 40 boys (table I), consisted of 11 h of physical activity per week, as compared to the previous maximum of 3 h.

A first assessment of physical fitness was made 12 weeks after the start of the program. At the same time, a like assessment was made with a control group of boys of the same age in a school in which not more than 3 h of physical training were given per week.

The test items used in this study have been described in the report of the International Committee on the Standardization of Physical Fitness Tests (ICSPFT) [Larson, 1974] and in the report on the Belgian Performance and Talent project [Hebbelinck and Borms, 1969]. The items and comparisons of the results for the two groups (Wilcoxon sign rank test for significant differences as interpreted at the 5% probability level) are shown in table II. The absolute values suggested the sports group was shorter in the legs, longer in the trunk, with greater thigh and calf girth and lesser calf fat. However, the tests of significance showed none of these values to be significant. Thus, it was appreciated that the sports and control groups were not radically different in the early phase of the program in most items. The sports group were better performers in three of the four performance tests.