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Changes in maximal aerobic fitness and students' attitude towards physical effort during outdoor and indoor school lessons of Physical Education

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Key words: *endurance, mood, feeling, effort fatigue, attitudes, Physical Culture.*

Abstract

Background: *The aim of the research was to determine an influence of an increased number of outdoor lessons of Physical Education on aerobic fitness and to evaluate students' attitude towards endurance efforts.*

Material/Methods: *In the presented research project a group of students participated in a school program of Physical Education on the basis of a higher number of lessons realized in the natural environment in the vicinity of school. The subjects were a group of 220 students from 4 schools of the Pomeranian Voivodeship, who were subjected to initial and final measurements during two school years. The most important assumption of the research stated better effects of outdoor classes of Physical Education in comparison with indoor classes and the shortage of experimental factor influence on the correlation change between objective and subjective indices of fitness and attitudes related to it.*

Results: *In the experimental group the most distinct differences between initial and final tests concerned the endurance measurement, similarly to the control group in which, however, the improvement in the final test was less noticeable. The correlation among three analyzed variables was significant for both research groups. The comparison of results of students from the experimental and the control groups demonstrates a positive influence of outdoor lessons on the level of endurance and, to a lower degree, on the feeling of effort fatigue and mood.*

Conclusions: *The research was conducted with a use of three research tools: the mood scale, Cooper's test and the subjective fatigue feeling with finished effort scale that allow a positive verification of the presented hypothesis, which should be an encouragement for wider practicing of innovative activities to bring closer the assumed aims of Physical Education to the aims actually achieved.*

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Introduction

During the last decades within the framework of Physical Education school process effective methods of improving educational effects both in the sphere of students' attitudes and measurable effects related to general physical fitness were looked for. Among often practiced methods pedagogical innovations were referred to. Through their assumptions an attempt was made to introduce student's coursebook for Physical Education [1] as well as to promoteparents and teachers' activity through participation in regular parent-teacher meetings of Physical Education [2]. The area of research encompassing regions with a low level of industrialization created conditions to verify positively hypotheses assuming better effects of lessons conducted in the open space in comparison with lessons realized in closed rooms [3]. From among researchconducted recently, mainly the Cracovian experiment deserves attention. The obtained results constitute a base for the statement that a change in school lessons organization and other than traditional system of evaluation may beneficially influence students' attitudes towards physical culture. On the other hand, the aim of an experiment conducted in Poznan was to find an answer to the question if co-operation with students in deciding about their own mark based on the system of development planning "decide yourself" is more effective in the context of educational effects than the traditional model of formative education, in which assigning tasks and execution of their accomplishment under teacher's controldominates. Most of these educational activities brought expected effects, whichconfirmsthe validity of such activities and encourages realizingthem more often.

We currently observeincreasing separation of man from nature, whose integral part he used to be, and which is induced by the development of civilization. Nowadays the eventuality of returning to its bosom seems to be unrealistic, and what is worse, unnecessary. Health of human body more and more often happens outside its ecological determinantswith a lack of awareness that nature is inorganic human body and that human body is part of the organic nature's order [6]. This resultsin a low number of people renewing their vital forces in nature, although the health properties connected with pollution and noise filtration and production of bactericidal organic aerosols are commonly known [7]. Relatively few national reports demonstrate that professional or school life exposes organism to nearly whole day functioning in closed rooms with increased temperature, low humidity, artificial light, excessive dust and often increased noise [8]. Also foreign sources inform about this, recognizing sanitary-hygienic condition of air in closed rooms [9] and their thermal conditions [10] as the most important limiting element.

In post-war Poland publications in a character of guides concerning physical exercises in an open area [11] also appeared. The period was also the beginning of an idea of a "green gymnasium". It occurred as an answer to poor infrastructure of schools in the range of physical culture and became an important example of pedagogical innovations. However, the idea did not witness realization on a broader scale but nonetheless in the following decades publicationspromoting it appeared [12].

The last two decades of the 20th century were a period of secluded pedagogical interventions turning lessons of Physical Education towards the surrounding nature. In mid-1980s experimental research was started in the area of Zamosc (Southern-Eastern Poland), the aim of which was to compare biological-health and educational effects of Physical Education lessons in an open space and in a gymnasium with initial assumption that better effects are achieved during outdoor lessons. The project was realized in two stages and witnessed both scientific analysis and studies of a didactic character [13].

The aim of the presented research was to determine an influence of an increased number of outdoor lessons of Physical Education on aerobic fitness and to evaluatestudents' attitudes towards endurance efforts. Its realization was based on a comparison of results of an initial and a final test in an experimental group and initial and final results in a control group. Also the direction and strength of correlation between variables subjected to analysis was determined, and a comparison of mood, endurance and fatigue for the experimental group with the results of the control group separately in the initial and the final test.

We assumed that lessons would be realized according to the same didactic-educational plan prepared for each pair of classes. Each teacher conducted the lessons in their classes

(experimental and control) according to the plan that included basic contests of a program possible to be realized, both in open areas and in the gymnasium, in which we referred to earlier research in this respect [3].

Material and methods

The presented project was realized in the school years 2000/2007 and 2007/2008. 220 students from 4 elementary schools of Pomeranian Voivodeship were included in the experiment. They came from 2 urban schools from Gdynia and 2 rural schools placed in Choczewo and Luzino in the north of the Voivodeship. In each school that participated in the project, there were 2 groups of boys (experimental and control) and 2 groups of girls (experimental and control). The research was realized at the second stage of education in four successive semesters, in the 5th and 6th grade of education. The experimental group consisted of 49 boys and 54 girls, whereas the control group of 54 boys and 65 girls. Students exercising more often in an open area came in a similar number from the city and the country (city – 49; country – 54). In the control group there were 57 students from the city and 60 from the country.

The main method applied in the research was a natural experiment as a confirmed method of pedagogical analysis [14]. It is based on testing a phenomenon in normal conditions and manipulation of conditions that is proposedby a researcher. The experiment needed the choice of both the experimental and the control group; the aim of the latter was to demonstrate the range of changes happening under the influence of a specific variable in a population involved in the experiment. The experimental factor and at the same time the independent variable was a higher number of outdoor lessons, which in all schools participating in the experiment took place in the closest vicinity of school. The number of outdoor lessons planned weekly was not precisely assumed because of changing weather conditions, especially during the autumn-winter period. Students participating in the experiment exercised outdoors always when the weather conditions were encouraging, which was sometimes up to four times a week.

Initially we based on previous research assumptions [3] that determined the number of outdoor lessons of Physical Education at a level of 75% for the experimental group and for the control group at a level of 25-33%. In the presented research we finally achieved an average level of 60-65% for experimental classes and 30% in the control group.

Independent variables were: mood before accomplishment of an effort test, endurance and subjective fatigue feeling,whereas mediating variables were climate elements, gender of the tested students and their place of living.

Three measurement tools were used in the research:

1. A 5-point mood scale that is a reflection of emotional attitude towards a lesson before its beginning. In the scale bad mood and dislike to the lesson is marked with 1 point and very good mood and willingness to participate in a lesson with 5 points. For the needs of research the tool was used before lessons with an identical program and more precisely before 12-minute Cooper's test.
2. Cooper's test – a 12-minute test that is used to evaluate the level of endurance, which is assessed with the meters of the covered distance [15]. Accomplishment of the recommended test on a running track was possible only in one of the schools, which is why in the remaining ones we marked out the closed route with laps of 50 meters on a plain area. We conducted 2 tests according to instructions for a 12-minute run [16], the first after 3 weeks from the day of the beginning of school year 2006/2007, which was an initial measurement and the second,which was the final measurement, at the end of school year 2007/2008.
3. Noble-Borge's scale applied by students directly after finishing Cooper's test. It is a subjective method to evaluate endurance effort's fatigue feeling which still met with positive opinions in case studies [17]. In the pre-test conducted in the school year precedingthe beginning of research we used a more widely known 15-point Borg scale with grading from 6 to 20, but similarly to earlier research [3], there were difficulties in mastering by children from the 4th grade. Therefore, in the initial and the final measurement we

applied 10-point Noble scale with co-authorship of Borg et al. [18], known as Noble-Borg's scale, in which the value of 0.5 point corresponds with very, very light effort and value of 10 points with extremely high effort.

We tried to realize the aim of the research by answering the following research questions:

1. To what extentthe mood of students participating in outdoor exercises differs from the mood of students exercising in a gymnasium?
2. How significant are the differences in endurance of children exercising outdoors and in the gymnasium?
3. In what way did the feeling of burden with effortamong student practicing more often outdoors change in the final phase of the project and was it lower than in the case of students from the control group?
4. To what degree are correlations between the level of mood and endurance, and the degree of effort fatigue feeling disclosed and are they connected with participation in outdoor lessons of Physical Education?

Own observations and literature analysis taking into consideration the posed questions allowedformulating the following research hypotheses:

1. Maximal aerobic fitness is higher and mood evaluation of burden with effortis better among students participating in outdoor lessons of Physical Education.
2. Participation in a higher number of Physical Education lessons in open near-school area should influence the change of correlation between mood, endurance and fatigue feeling.

In the overwhelming number of cases during statistical analysis we stated a lack of normal distribution. It was the base for using non-parametric tests of differences significance. A comparison of the experimental group and the control group in the initial and the final tests of mood, endurance and subjective fatigue feeling was based on a graphic presentation of data collected in form of a diagram. We also accomplished evaluation of connections between the mentioned variables, for which Spearman's correlation rangecoefficient was used. In turn, to compare mood, endurance and subjective fatigue feeling in the experimental and the control group in the initial and the final test, U Mann-Whitney test was applied. For all calculations we assumed that the level of statistical significance that does not exceed 5% of random mistake ($p<0.05$), marking statistically significant caseswith bold print.

Results

The comparison of the initial and the final tests' results separately for students realizing most Physical Education lessons in open area and in the gymnasium shows higher positive changes for the first group. In the scope of mood we did not find differences between both tests in the control group (Fig. 1).

The set of Cooper's test results revealed more significant differences. Both groups presented a similar level of endurance during the initial measurement, but during the research students of the experimental group more effectively shaped endurance (Fig. 2).

Also in the case of fatigue feeling the evaluation after accomplishment of the endurance test, the improvement was demonstrated only in the case of experimental participants, who recognized the completed effort as lighter than in the initial test, which means they marked it with lower grading. For the control group we did not state differences between the initial and the final measurement (Fig. 3).

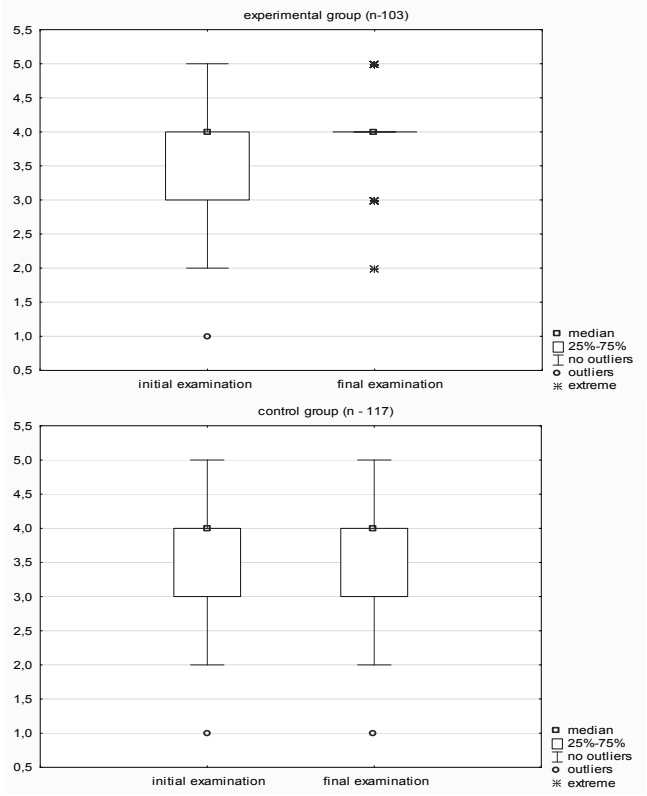

Fig. 1. Comparison of mood results (in points) in the initial and the final test, separately for the experimental and the control group

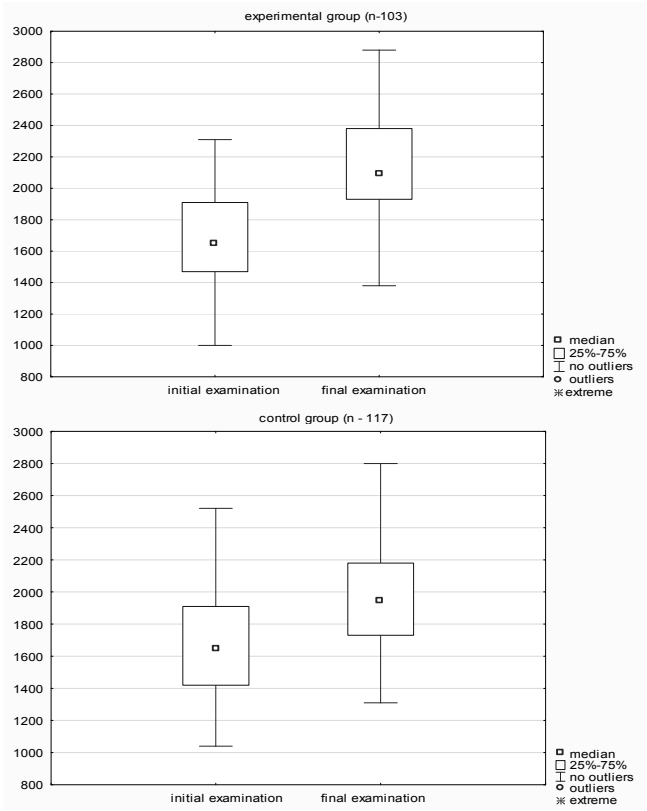

Fig. 2. Comparison of endurance in the initial and the final test, separately for the experimental and the control group

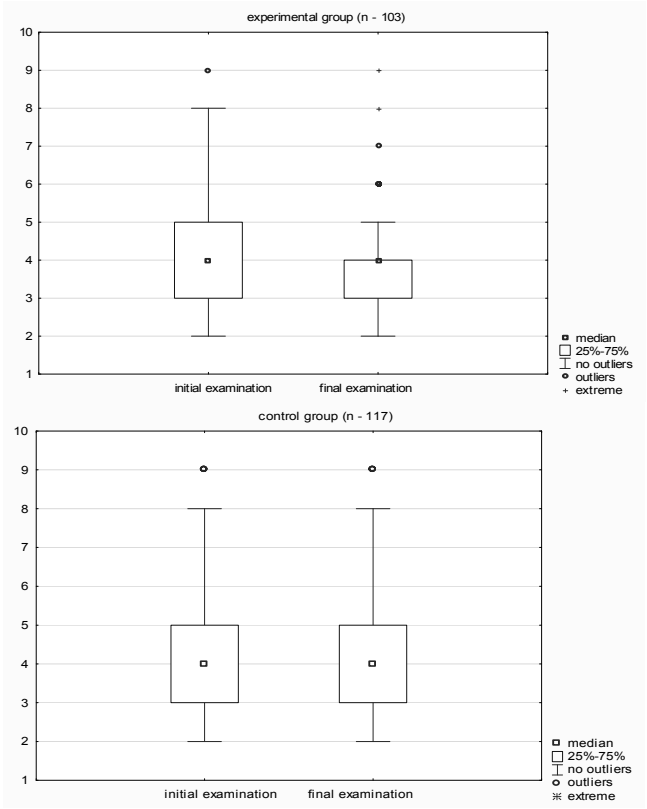

Fig. 3. Comparison of subjective effort fatigue feeling (in points) in the initial and the final test, separately for the experimental and the control group

Analysis of correlation between the tested indices of fitness and attitude brought very similar results regardless of the time of measurement accomplishment. We noticed statistically significant negative connections between mood and fatigue, and statistically significant positive connections between mood and endurance. The relationship between the level of endurance and the level of fatigue in both groups had a negative sign; however, in the experimental group it did not have marks of statistical significance in any of the two conducted measurements (Tables 1 and 2).

Tab. 1. Correlation coefficient between mood, endurance and subjective fatigue feeling in the experimental and the control group in the initial measurement

Group / Feature	Experimental group (n =103)			Control group (n = 117)		
	mood	endurance	tiredness	mood	endurance	tiredness
Mood	**1.0000**	**0.2720**	**-0.4528**	**1.0000**	**0.3876**	**-0.7088**
Endurance	**0.2720**	**1.0000**	-0.1662	**0.3876**	**1.0000**	**-0.3526**
Tiredness	**-0.4528**	-0.1662	**1.0000**	**-0.7088**	**-0.3526**	**1.0000**

Tab. 2. Correlation coefficient between mood, endurance and subjective fatigue feeling in the experimental and control group in the final measurement

Group / Feature	Experimental group (n =103)			Control group (n = 117)		
	mood	endurance	tiredness	mood	endurance	tiredness
Mood	**1.0000**	**0.3681**	**-0.6537**	**1.0000**	**0.4445**	**-0.8020**
Endurance	**0.3681**	**1.0000**	-0.2256	**0.4445**	**1.0000**	**-0.3773**
Tiredness	**-0.6537**	-0.2256	**1.0000**	**-0.8020**	**-0.3773**	**1.0000**

The initial measurement of mood, endurance and subjective fatigue feeling in the experimental and the control group revealed very similar results. During the final test we noticed a distinct advantage of students from the experimental group with respect to endurance and close to statistical significance its advantage with respect to mood. Also nearly unnoticeable during the initial test differences in the level of fatigue significantly increased during the final measurement in favor of students participating more often in outdoor lessons of Physical Education (Tables 3 and 4).

Tab. 3. Comparison of mood, endurance and subjective fatigue feeling in the experimental and the control group during the initial test

Feature / Group	Mood			Endurance			Tiredness		
	$\bar{x}$	M	SD	$\bar{x}$	M	SD	$\bar{x}$	M	SD
Experimental group	3.72	4	0.83	1681	1650	308	4,27	4	1,47
Control group	3.70	4	0.83	1694	1650	342	4,30	4	1,53
Level of significance		0.8576			0.9788			0.9534	

Tab. 4. Comparison of mood, endurance and subjective fatigue feeling in the experimental and the control group during the final test

Feature / Group	Mood			Endurance			Tiredness		
	$\bar{x}$	M	SD	$\bar{x}$	M	SD	$\bar{x}$	M	SD
Experimental group	4.05	4	0.69	2146	2090	333	3,85	4	1,29
Control group	3.84	4	0.80	1987	1950	336	4,19	4	1,53
Level of significance		0.0611			**0.0005**			0.1693	

Discussion

The obtained results concerning mood before completing the endurance test brought interesting observations, mainly in relation to the final measurement. In the initial test the differences in grading between the experimental and the control group were nearly unnoticeable (the average number of achieved points was 3.72 and 3.70, respectively). The final test suggests a significant role of the experimental factor in shaping both variables (mood evaluation 4.05 in the group involved in the experiment and 3.84 in the control one). Tests of children from the area of Zamosc [3] were partly similar in research assumptions concerning the influence of lessons in open area and a gymnasium on mood. However, in their case students' mood was analyzed before each lesson, unlike in the present test only before completing the endurance test. The Zamosc test indicates slight differences in favor of the experimental group in the first test (4.61 to 4.55) and higher ones in a test repeated a few years later on a different group of students (4.38 to 3.96). During analysis 2 regularities were noticed: in the first test evaluations of lesson standardized during winter months, only to differentiate in favor of the experimental group at the beginning of the school year and in spring; however, in the repeated test we noticed an alarming symptom of a general decrease in the mood level before a lesson in comparison with the first test [3]. Also experimental research from Krakow [4], in which a 5-point mood scale was applied, demonstrated better mood before lessons among groups that choose outdoor activities independently, and better one in the case of boys than among girls, which can be treated as a confirmation of a positive influence of the pedagogical experiment on attitudes towards physical culture.

Endurance tests with the use of Cooper's test indicated a positively modifying influence of outdoor Physical Education lessons on this element of physical fitness. The initial level of endurance was very similar in both groups: during 12 minutes students from the experimental group covered the distance of 1,681 m and students from the control group the distance of 1,694 m. In the final research both groups achieved on average 2,146 m and 1,987 m, respectively. It gave an average increase in distance of 465 m among students exercising more often outdoors and 293 m in the case of the control group. The results can be related to the most methodologically close research

conducted in Podkarpacie area [3], where during the first phase of research during four measurements girls achieved average results in the range of 1,880 and 2,190 m in outdoor groups and 1,947 to 2,067 m in groups from a gymnasium. Among boys we observed noticeable differences in favor of students participating in the experiment – during 4 tests they achieved 2,175 to 2,571 m, whereas the range of 2,132 to 2,273 m among boys from control groups. The results for groups exercising in open area were confirmed in a test repeated a few years later, however, without a breakdown into gender [3]. Students from the experimental group increased the distance covered during 12 minutes from 1,952 to 2,216 m and students from the control group only from 1,999 to 2,028 m. The comparison of the obtained results with simultaneously conducted measurements in the central-east macro region of the country [19] points to better results of the analyzed groups of students. According to standards [19], normative results of both genders, in the experimental and the control group, can be considered as good. However, national proposals of norms for the level of endurance [20] and based on centile values other Polish [16] and foreign norms[21,22] are definitely more rigorous and qualify endurance achieved in the present measurements as low or very low.

Research connected with fatigue feeling has been conducted since the beginning of the 1980s with the use of 15-point Borg's scale; however, with time researchers encouraged to analyze it more deeply only in relation to adults, as the perception of burden with effort is quite limited among children [23]. Nevertheless, researchers noticed connections between the degree of effort and increasing fatigue feeling induced by it [24]. In an overwhelming number of cases a practical application of extended scale was challenged because of a misunderstanding of both the description of the scale's grading and a high number of points. In connection with this, simplifying it for the needs of testing children was suggested [25], even though Noble [18] made earlier an effective attempt to create it. Similarly to Cooper's test, the differences in subjective fatigue feeling with effort were minimal in the initial test (average results of 4.27 in the experimental group and 4.30 in the control group). Meanwhile, the final measurements brought a more significant difference within this index, as value of 3.85 points in experimental group corresponds with 4.19 points in the control group. The results can be related to the results obtained by students from Podkarpacie in different parts of Physical Education lessons [3]. During the first test students evaluated effort intensity as follows: during outdoor warm-up – 2.84, in a gymnasium – 2.72, in the peak of the main part it was respectively, 4.08 and 4.35 points and at the end of the lesson's main part 3.28 and 2.89. However, in the second test the results were as follows: 3.61 and 3.17 during warm-up, 4.08 and 3.17 in the peak of the main part and 3.24 and 2.80 at the end of the main part. In both tests outdoor lessons were assessed as more intense.

Correlation analysis between mood, endurance and effort's evaluation points to numerous connections between these elements. Connections between physical fitness, among them endurance, and positive measures of health, such as good mood or moderate fatigue with physical effort, are complex and difficult to interpret, mainly when considering their multifactor determinants, as well as because of methodological difficulties in evaluation of physical activity and health [26]. In the absence of direct references in literature to connections of endurance with fatigue feeling or mood, it is worth noticing connections between the level of fitness and risk factors, among them between lipid density, obesity and increased arterial blood pressure [27]. When considering emphasized connections between effort fatigue feeling and the heart rate achieved during this effort [18], we should also mention negative connections between HR frequency during sub maximal effort and the results of a step-test [28], and VO2max [29]. A strongly negative correlation was also observed between strictly associated with the level of physical fitness absence from Physical Education lessons, and students' health self-assessment, among them headaches, back pains and stomachaches [30]. The same author also points to a lack of observed connections between school absence, tiredness, sluggishness, nervousness and bad mood. In turn, in many publications physical activity of an aerobic type is credited to be connected with the mood level, a reduction in physiological after-effects of stress [33], limitation of fear and depressive states and mood improvement [33].

Against a backdrop of results obtained by students from the experimental and the control group, interesting are data related to gender and the place of living. Achieving better results in the endurance test by boys was evident in comparison with girls ($p<0.01$), whereas endurance of rural and urban students did not differ significantly. Similarly, in the context of mood evaluation and evaluation of effort fatigue feeling, both gender and the place of living proved to be insignificant. This shows that in shaping students' attitude towards endurance effort, independent variables have a higher significance than mediating variables.

Conclusions

Taking stand towards the first research question, it should be stated that conducting a higher number of Physical Education units in outdoor area effects in improvement of mood before completing an endurance test, which is indicated with higher average scoring of this element among students from the experimental group. Although comparison with other authors' results, especially concerning foreign research, indicates generally weekly developed endurance, we observe significantly better results of measurement of this constituent of physical fitness among students exercising more often in an open area. This was confirmed by a more significant improvement in the effort fatigue index in the group undergoing experiment, whose members felt lower tiredness during the final measurement than participants of the control group, whereas during the initial test the difference was minimal. Referring to the question about connections between the level of mood and endurance, and the level of fatigue with physical effort, it was demonstrated that the correlations are quite strong, except for connections between endurance and fatigue in the experimental group in both tests. The pedagogical intervention students of the experimental group were exposed to did not influence the change of direction or the strength of correlations between the tested variables.

Research analysis allows verifying positively the presented hypotheses and formulating the final conclusions:

1. The results obtained by the experimental group in the final test proved to be better than the initial results, which concerned all three analyzed parameters.
2. In the final tests students from the experimental group demonstrated better endurance and better, however on the border of statistical significance, mood than students from the control group.
3. Correlations between three dependent variables are in most of the cases statistically significant, both in the experimental and the control group.
4. Pedagogical intervention in the form of a higher number of Physical Education lessons organized in near-to-school area did not influence the change in strength and direction of the correlation between mood, endurance and subjective feeling of fatigue with effort.

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