IN SEARCH OF SIMPLE METHODS FOR EVALUATION OF AEROBIC ENDURANCE IN SCHOOL CONDITIONS

by

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According to results of repeated researches, the level of aerobic endurance of contemporary Polish school children has undergone a dangerous decline. It is then necessary to counteract this undesirable tendency in the process of physical education. For evaluation of the level of aerobic endurance runs at various distances were applied. Such measurements are difficult to conduct in the process of physical education due to the lack of running tracks on the customary school sport fields. This paper assesses the eligibility of a 8-minute run on the handball sports field with an asphalt surface, both "shuttle run" and "8-shap run", to diagnose the endurance. Testing of over 3000 girls and boys, aged 10-18, have proven adequate reliability and selectivity of the proposed measuring tools, as well as their high accuracy and economics in the diagnosis of aerobic endurance of school children.

Key words: aerobic endurance, motor abilities diagnosis, endurance tests.

Introduction

The repeated research projects on motor fitness of Polish school population from 60's till 90's show the regressive tendencies in the level of its elements, especially in case of endurance (Przewęda, Trześniowski 1981; Przewęda 1985; Raczek 1986, 1995; Szopa, Żak 1986; Drabik 1989, 1992; Żak 1991; Pośpiech 1992). It may be assumed, with high probability, that this fact causes the increase of cardiovascular deseases, which begin to be the plague for younger and younger generations.

Signalized tendencies may be explained as natural changes of human "fitness profile" which are the consequence of preferred by younger generations

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models of movement activity. Mainly they are based on new, attractive movement forms generally with strength-coordination and speed character. The acceptance of these general changes do not allow to forget about motor fitness, because it may cause a decrease in adaptation of human body and negative health consequences (see review by Bouchard et al. 1997).

In light of presented facts it seems to be especially important to develop the proper structure of motor fitness in children and youth. Aerobic endurance (long-time) based on the efficiency of the cardiovascular system plays a significant role in this area. The basic method for this type of endurance development includes continous exercises with stabilized or changing intensity, lasting longer than 5-6 minutes. This form of exercise is however very rarely used by physical education teachers.

The "aerobic programs" became very popular in many countries, which assume improvement through activity of aerobic character, what increases also the level of general fitness (Cooper 1981; Kuński 1985; Drabik 1989, 1995; Raczek 1995). The perspective aim of such programs is health prevention through promotion of proper forms of movement activity and cardiovascular development.

In light of presented facts it seems very important to search for simple measuring methods for evaluation of aerobic endurance in school conditions. The most popular and informative in the evaluation of long-term endurance are outdoor, continous runs, measured by distance or with pre-defined time. The lack of athletic tracks on school areas makes impossible to use them widely and it causes the neccessity of new solutions. The shuttle run with increased speed over a 20 m distance, proposed as a indirect method of cardiovascular capacity by EUROFIT authors (1988) may be a good example of such attempts. The complexity of measuring procedures of this test did not allow, however, to gain great popularity among physical education teachers. Because of this, the author attempted in this paper to find a new method of aerobic endurance evaluation in school conditions based on the idea of a shuttle run and a continous run on small fields or playgrounds.

The main aim of conducted experiments was the determination of validity, reliability, selectivity and economy of aerobic endurance evaluation in boys and girls aged 10-18 with the use of "figure 8" run and a "shuttle" run on the

handball field. The simplicity and outdor performance posibility are the advantages of both tests. It is also very important in case of endurance testing for physiological and hygenic reasons. It should be also underlined that the shuttle run with increasing velocity according to EUROFIT instructions (1988) may be performed indoor with minor modifications.

Material and Methods

The measurements were conducted on 3722 pupils aged 10-17 (1743 females and 1979 males). The representatives of this age period indicate the greatest negative tendencies in the level of aerobic endurance (Przewęda. Trześniowski 1981; Raczek 1986, 1995). The evaluation of aerobic capacity development in the process of physical education is in this age group especially desirable and simulatenously very difficult to conduct in the form of generaly exepted 12-minute run.

The measurements were performed in October and September in chosen schools in three counties: Śląskie, Opolskie, Małopolskie. It was conducted by the team of physical education teachers, prepared theoretically by the author of the paper. The evaluation was conducted in two groups. First group (751 girls and 882 boys) was tested twice with the use of the 8-minute run on the "figure 8" track (30 m x 15 m) on asphalt fields. The assumption was made that the proposed method of evaluation is most similar to continous runs on athletic tracks. The aim of this research was the determination of reliability of this test as an tool for the evaluation of endurance.

The second group, similar in amount of subjects (714 girls and 1103 boys) performed the endurance evaluation with the use of "figure 8d" run and 30 m shuttle run. The aim of this part of experiment was the determination of validity of the "figure 8" run in relation to the shuttle run treated as a already verified method of endurance evaluation. The distance from srtart to finish, in this case, is 10 m longer in comparison to the EUROFIT shuttle run what allows to decrease the amount of turns by 1/3 and makes this test more similar to a continous one. The experiments were performed in two groups in order to avoid three endurance performances of pupils in one month.

8 minute "figure 8 run"

Four markers were placed in the corners of the 30x15 m rectangle on the asphalt handball field. With the use of chalk the movement directions were marked on the surface (fig. 1). Eight pupils were tested simultaneously and they started in pairs from different corners of the rectangle. Each subject had "referee", who counted the amount of laps and evaluated the heart rate 30 s after the finish. In statistical analysis, only subjects with heart rate greater than 180 were included.

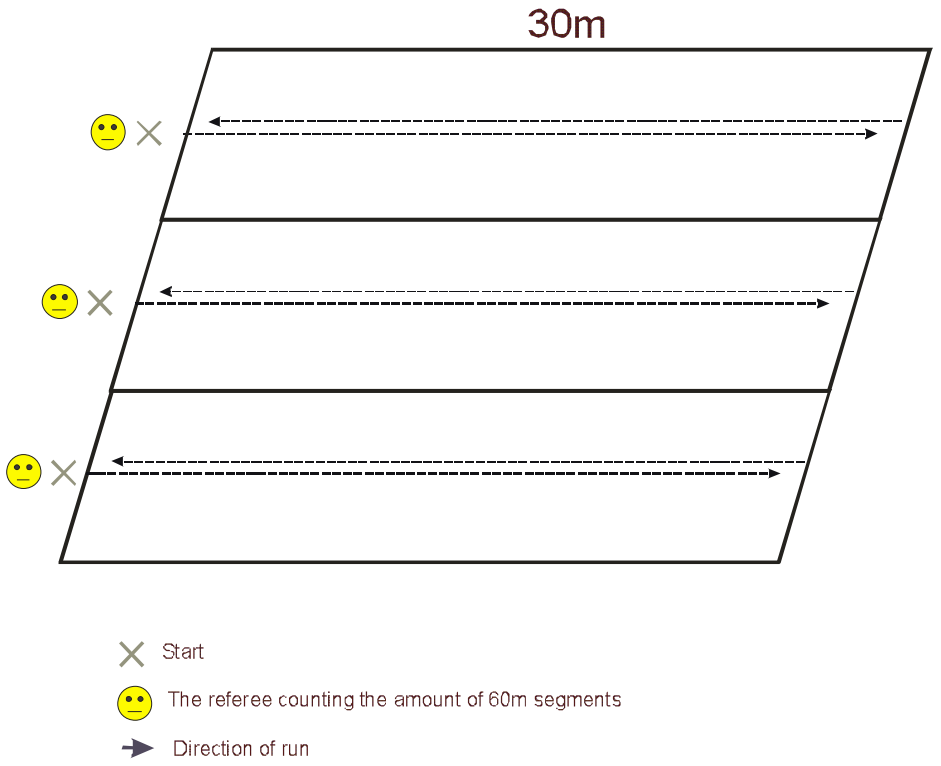


Fig. 1. The scheme of the shuttle run

After the "start" command subjects ran according to the described track during 8 minutes. During the time of the test they were informed about the time of the trial and were motivated to continue the run. After a "stop" command subjects stopped and "referees" determined the amount of laps. The number of laps was multiplied by 100 (the distance of the figure 8d track was equal to 100m) and the distance of the last lap was added to the result.

30 m shuttle run in 8 minutes

On the asphalt handball field two parallel lines (30 m distance) were marked with chalk with 8-12 subjects lined up at one of them (fig. 2). After "start" command subjects started to run from one line to the other. The turn was done after crossing the line with one leg. Each subject had a "referee", who counted the amount of laps and revaluated the heart rate 30 s after the finish. The run was continued fo 8 minutes, and after each 60 s the time of the run was declared. After the "stop" command subjects stopped and "referees" determined the amount of laps. The number of laps was multiplied by 30 and the distance of the last lap was added to the result.

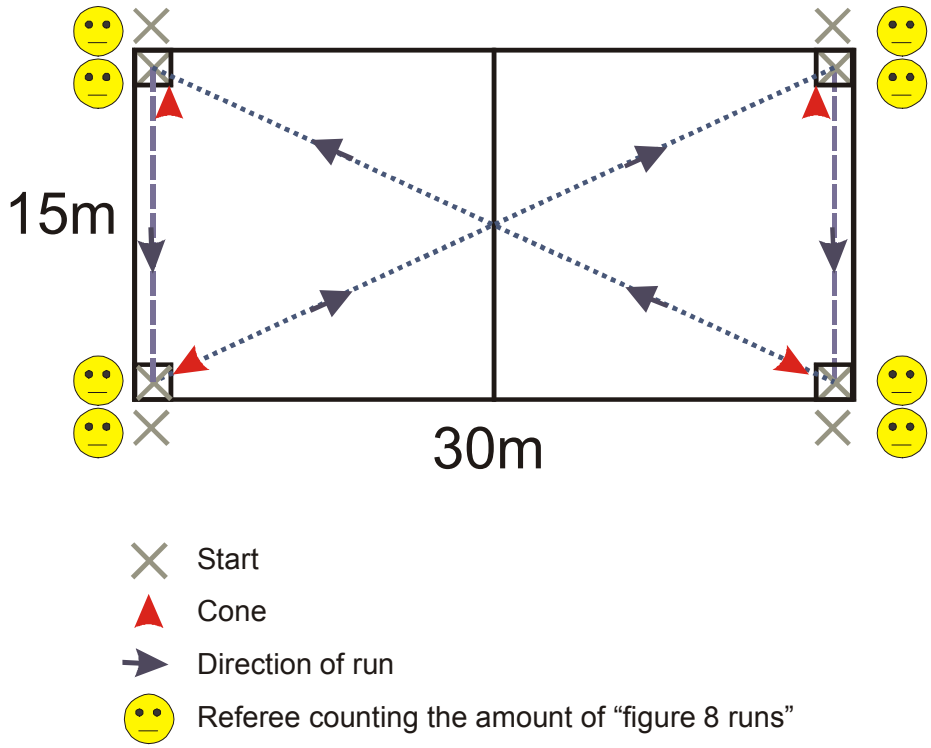


Fig. 2. The scheme of the "figure 8 run"

Statistical methods

The basic descriptive statistic parameters were calculated in case of age and gender: arithmetic mean ($\bar{x}$), standard deviation (SD), coefficient of

variability (V) and skewness (sk). The range (max.-min.) was also determined. These parameters allowed, among others, for evaluation of selectivity of used measuring methods.

The correlation coefficients between the results of first and second measurement in age and gender groups were also calculated. In the first group the "figure 8 run" was the base for the determination of reliability as a method of endurance evaluation, and in the second group its concurrent validity in relation to the "shuttle run".

Results and discussion

The collected data allowed for the attempt to evaluate assumptions about validity criterions of the used measuring methods. All the dispersions were normal in age and gender groups (sk). Average distances achieved by subjects in the first and second "figure 8 run" in the first group and the same test in the second group are similar (table 1,2). More often, especially in girls, little better results occurred in the second run, what probably was do to better pacing at the distance after first run experiences (majority of subjects took part in such an experiment for the first time).

The variability coefficients (V) oscillate in girls from 6,4 to 17,2% (figure 8) and from 8,2 to 15,9% (shuttle), in boys from 4-9 to 14,1% (figure 8) and from 8,8 to 18,6% (shuttle). They are clearly lower in boys of high school, what was caused probably by smaller number of subjects in group aged 16-18. Generally it is possible to state that dispersion measures (SD, V) show proper selectivity of both used measuring methods evaluating the level of aerobic endurancee in subjects aged 10-18 (table 1-4).

In light of criterions proposed by Zaciorski (1979) the relability of the "figure 8 run" in consecutive age and gender categories is good (r>0,90) or permissible (0,80-0,90). Only one exception occurred in 13 year old girls, where the repeatibility coefficient is close to upper critical level (0,78). Clearly higher reliability was determined in boys (table 1,2).

Table 1. Descriptive statistics in first group of girls

Age (years)	n	Test	x	max	min	S	V	Sk	r
10	122	I	1222,1	1650	880	115,4	10,7	-0,2	
		II	1236,6	1520	900	121,8	11,3	0,4	0,88
11	134	I	1335,0	1640	950	133,1	9,9	-0,6	
		II	1347,6	1650	900	166,6	12,4	0,6	0,86
12	158	I	1375,0	1680	1000	102,5	7,4	-0,2	
		II	1387,2	1650	950	108,4	7,7	0,3	0,82
13	159	I	1346,3	1670	1000	134,8	10,4	0,5	
		II	1370,6	1730	980	167,7	12,4	0,6	0,78
14	178	I	1295,3	1660	1040	158,8	12,7	0,5	
		II	1320,8	1580	980	169,6	13,2	0,2	0,85
15	108	I	1344,4	1560	1160	104,2	7,7	0,3	
		II.	1356,0	1540	1180	90,5	6,8	-0,1	0,93
16	60	I	1379,3	1660	1200	109,7	7,9	0,4	
		II	1398,0	1620	1200	102,6	7,3	0,0	0,88
17	56	I	1343,9	1520	1100	92,4	6,9	-0,4	
		II	1378,5	1560	1120	87,9	6,4	-0,3	0,90
18	54	I	1362,0	1900	1180	147,2	10,8	1,3	
		II	1372,2	1960	1200	140,5	10,2	1,1	0,92

Table 2. Descriptive statistics in first group of boys

Age (years)	n	Test	x	max	min	S	V	sk	r
10	152	I	1324,4	1700	940	141,1	10,6	0,4	
		II	1337,8	1750	960	150,5	11,2	0,6	0,94
11	174	I	1399,3	1800	1000	158,5	11,3	-0,1	
		II	1404,6	1720	1020	160,5	11,5	0,2	0,90
12	160	I	1490,3	1840	1000	198,2	13,8	-0,3	
		II	1516,6	1920	1050	204,7	14,0	-0,2	0,89
13	199	I	1550,3	1940	1200	193,5	9,1	-0,6	
		II	1554,0	1900	1200	173,9	11,0	-0,6	0,91
14	197	I	1682,3	2230	1100	232,5	13,7	0,9	
		II	1708,0	2300	1120	240,4	14,1	1,2	0,93
15	137	I	1730,5	2180	1400	143,4	8,2	1,2	
		II.	1772,8	2240	1520	164,7	9,3	1,2	0,84
16	74	I	1820,0	2220	1200	199,1	10,3	-0,6	
		II	1850,6	2280	1230	199,2	10,3	-0,6	0,89
17	86	I	1902,3	2000	1300	138,9	7,6	-0,9	
		II	1938,0	2040	1420	127,6	6,9	-0,5	0,94
18	88	I	1895,0	2200	1660	107,6	5,6	0,1	
		II	1932,8	2160	1760	94,3	4,9	0,2	0,93

Table 3. Descriptive statistics in second group of girls

Age (years)	n	Test	x	max	Min	S	V	sk	r
10	141	b. ósem	1187,2	1540	740	210,3	17,7	0,7	
		b. wah.	1152,4	1560	780	191,1	15,9	-0,3	0,88
11	130	b. ósem	1374,1	1680	1200	124,5	8,8	0,7	
		b. wah.	1329,5	1590	1080	116,8	8,5	0,3	0,70
12	146	b. ósem	1388,3	1740	1280	133,7	8,8	1,7	
		b. wah.	1380,5	1720	980	160,8	10,8	0,4	0,83
13	155	b. ósem	1322,0	1650	990	167,4	11,9	1,2	
		b. wah.	1298,5	1580	960	169,3	12,5	0,2	0,81
14	142	b. ósem	1313,0	1700	950	201,3	15,3	-0,4	
		b. wah.	1364,5	1690	960	194,6	14,7	-0.4	0,82
15	54	b. ósem	1315,2	1660	980	135,0	9,1	0,3	
		b. wah.	1325,4	1710	1000	107,2	8,2	-0,1	0,76

Table 4. Descriptive statistics in second group of boys

wiek (lata)	n	próby	x	max	min	S	V	sk	r
10	153	b. ósem	1352,1	1630	990	140,9	10,4	-0,4	
		b. wah.	1292,3	1700	900	164,2	12,7	-0,4	0,77
11	143	b. ósem	1410,1	1830	950	202,6	13,6	-0,4	
		b. wah.	1389,3	1960	960	206,0	13,7	-0,7	0,83
12	143	b. ósem	1504,3	1900	910	179,2	11,7	-0,5	
		b. wah.	1431,6	1760	960	159,6	10,4	0,1	0,93
13	137	b. ósem	1535,0	2040	1280	219,9	13,0	0,3	
		b. wah.	1504,4	2000	1220	223,5	13,8	-1,2	0,83
14	136	b. ósem	1602,3	2110	1380	191,4	11,2	-1,0	
		b. wah.	1665,5	2230	1170	200,9	11,9	-1,0	0,88
15	137	b. ósem	1742,5	2180	1200	143,4	8,2	1,2	
		b. wah.	1721,3	2110	1210	202,0	11,7	-0,1	0,86
16	74	b. ósem	1816,8	2220	1180	198,1	10,3	-0,6	
		b. wah.	1766,2	2330	1200	320,2	18,6	0,4	0,83
17	86	b. ósem	1812,9	2000	1300	138,9	7,7	-0,9	
		b. wah.	1734,4	2160	1250	292,4	17,5	-0,3	0,91
18	94	b. ósem	1912,0	2200	1300	107,6	5,6	0,3	
		b. wah.	1826,5	2140	1250	144,2	8,8	-0,5	0,90

On the basis of Pearson correlation coefficients between the results of the "figure 8 run" and "shuttle run" (in second group of subjects) the concurrent validity (statistical) of this first trial. Shuttle run, as was mentioned earlier, was treated as verified. The data included in last column of table 3 and 4 shows that validity of the "figure 8 run" in relation to "shuttle run", in boys and girls, is

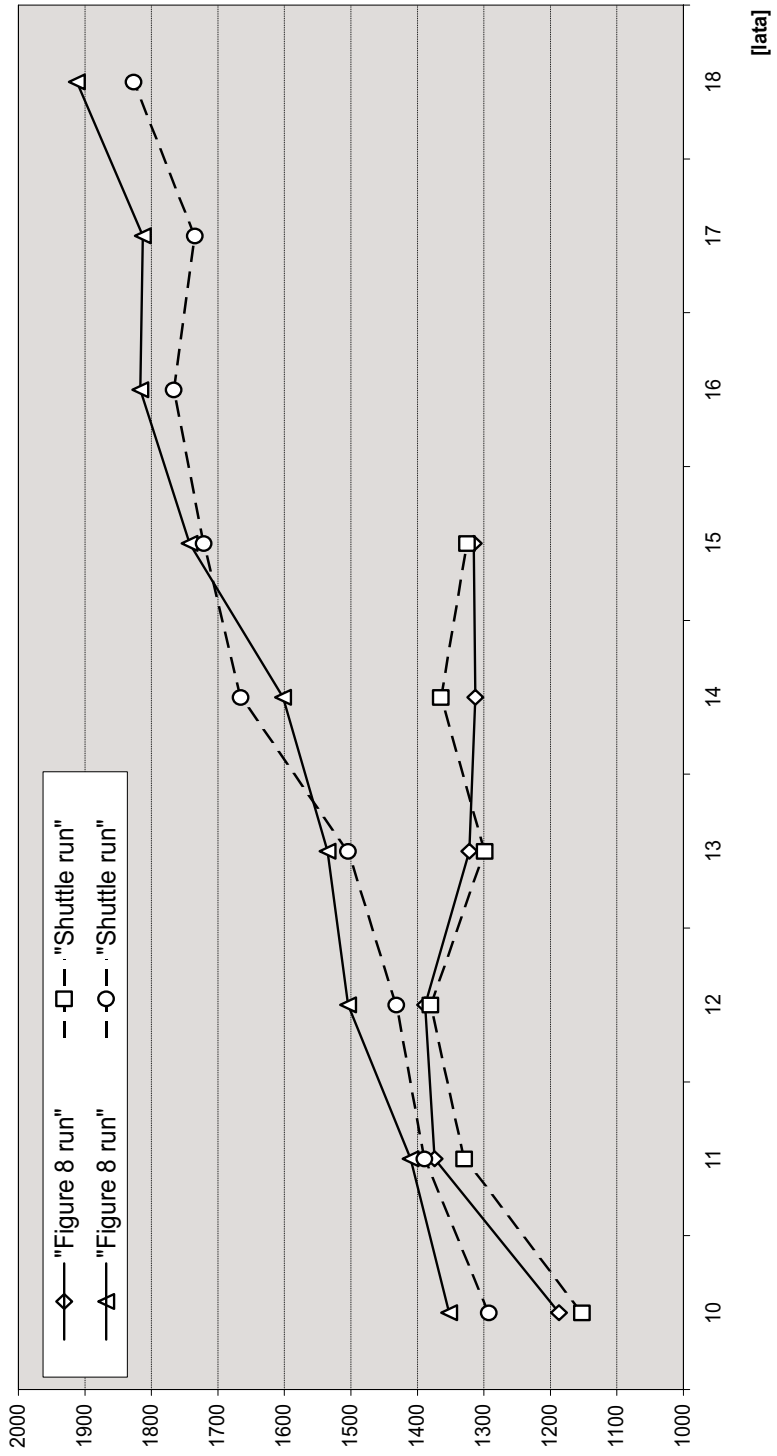
high, and higher in the last ones. It is postulated in literature to acquire a level of correlation higher than 0,60 (Zaciorski 1979). There is no data in case of girls aged 16-18, because the amount of tested subjects was less than 50, too small of a number for valid conclusions.

Acquired developmental variablity of endurance, in boys and girls, similar to existing literature, may be treated as an additional evaluation of validity of both used methods (Raczek 1986, 1995; Drabik 1989, 1992; Szopa et al. 1996 and others). The increase of aerobic endurance from 10 to 12 years and stagnation (even a small regress) in consecutive age categories was determined in girls. In similar time periods a continous improvement of endurance abilities occurred in boys aged 10-18 (table 1-4, fig. 3,4). Presented above facts allow to describe the "figure 8" run as a valid measuring method for evaluation aerobic endurance in subjects aged 10-18.

Both used measuring methods are economic in light of the commonly used in that case 12-minute run, because the time was reduced to 9 minutes. It is allowed in case of non-athletes because aerobic processes are fully activated already in the 6-8th minute of exercise (Raczek 1981; Żarek 1996). Because of this, the 8-minute continous run is used in evaluation of aerobic endurance in children and youth also in Germany, Russia, while a 9-minute run is used in the USA, Canada and Netherlands (Grosser, Starischka 1986; Ljach 1999). In the USA the 1 mile run is also used in the evaluation of aerobic endurance in youth. In each test 8 to 12 subjects may participate simultaneously ("figure 8 run") ("shuttle run"), what allows to test during one class the whole group of pupils. The educational effect of common testing (counting of laps and motivtion) is also very important.

Resuming it should be underlined, that in case of a decrease in the level of motor fitness, in contemporary school population it is very important to develop rationally the aerobic endurance of pupils. The efficiency of activities in this area may be evaluated using the mentioned methods. In order to do that, in school withou the athletic track, the "figure 8" and "shuttle" runs may be performed on the handball fields.

In light of presented experiemntal data, both tests seem to be reliable, valid, selective and economic measuring methods in evaluation of aerobic endurance in boys and girls aged 10-18.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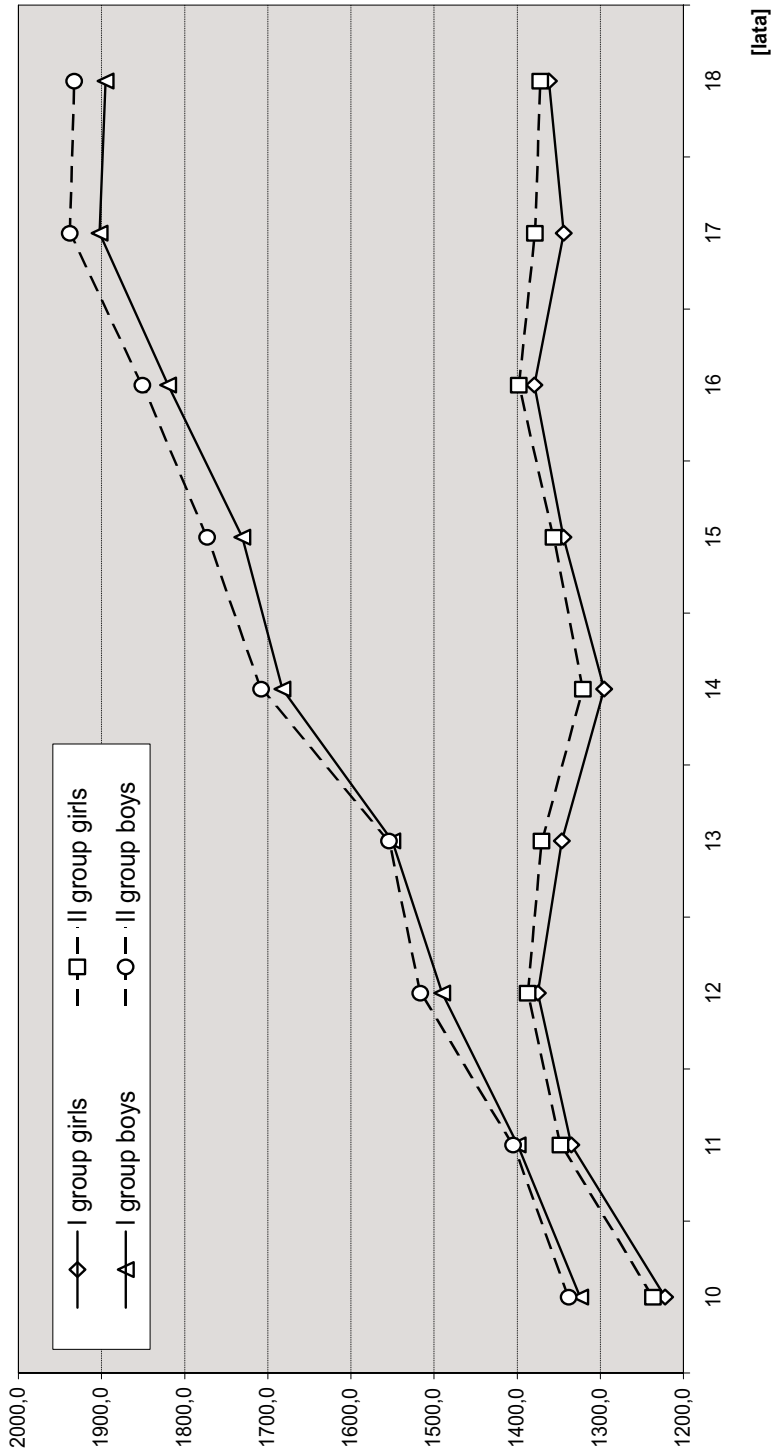
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I group girls
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Conclusions

1. The used measuring methods for evaluation of aerobic endurance are sufficiently selective in the population of pupils aged 10-18.
2. The "figure 8 run" is a reliable measuring method for pupils from elementary and secondary schools.
3. This test has a high concurrent (statistical) validity in relation to the "shuttle run".
4. The mentioned measuring methods may be treated as valid motor tests, useful and economic in diagnosis of aerobic endurance in school conditions.

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