PHYSICAL FITNESS OF CHILDREN AGED 10 YEARS PARTICIPATING IN PHYSICAL EDUCATION CLASSES ENRICHED WITH COORDINATION EXERCISES

Marek Popowczak*, Andrzej Rokita**, Ireneusz Cichy*, Paweł Chmura***

* PhD, Department of Team Sports Games, University School of Physical Education in Wroclaw, Poland
** Dr. Habil., Assoc. Prof., Department of Team Sports Games, University School of Physical Education in Wroclaw, Poland
*** MSc, Department of Team Sports Games, University School of Physical Education in Wroclaw, Poland

Key words: physical fitness, coordination motor abilities, physical education

SUMMARY

Aim of the study. To determine changes in the level of selected coordination motor abilities and individual components of physical fitness in students aged 10 years that occurred as a result of implementing a special (based on authorial programme) curriculum of physical classes enriched with coordination exercises.

Material and methods. The study participants comprised 92 students at two primary schools in Wołów. A method of pedagogical experiment carried out by means of parallel group technique was employed. During 1 of the 6 teaching hours of physical activities in each week, the experimental groups spent 20 minutes on developing the indicators of selected coordination motor abilities. The results achieved by the experimental groups were compared with the results obtained by the control groups that conducted the so-called traditional curriculum of physical education. After that, the changes in the level of selected coordination motor abilities were analysed, i.e., spatial orientation, quick reaction, kinaesthetic differentiation and movement adaptation. For the purpose of determining the level of children's physical fitness, the trials of the International Committee on the Standardization of Physical Fitness Tests ICSPFT were used. All the groups underwent the aforementioned trials twice, namely at the beginning and at the at the end of the 2010/2011 school year.

Results. On completion of the new curriculum of physical classes that were enriched by coordination exercises, an increase in the level of selected coordination motor abilities and physical fitness diagnosed by the International Physical Fitness Test ICSPFT was observed in all experimental groups. On the other hand, control groups mostly achieved unfavourable or insignificant changes with regard to the development of the researched coordination motor abilities and physical fitness.

Conclusions. The obtained results prove the assumption that by systematically conducting coordination exercises it is possible to achieve changes in the level of selected coordination motor abilities and physical fitness. It must be emphasized that this process ought to assume a long-term nature and the character of teacher’s impingements cannot be merely sporadic or periodic.

Introduction

Children today show an ongoing deficit in motor development. Most of them grow up in a physically passive environment in which watching television and using computers are dominant forms of spending one's free time [1, 2]. Regularly conducted physical education lessons or additional motor classes should aim to create situations in which the student, by learning to move, develops motor habits and increases fitness. Yet at the same time, the student acquires valuable and necessary social experience (the participants learn to trust themselves, discover and learn truths about themselves, and learn respect and tolerance towards other people and how to cooperate with them) [3, 4, 5]. A child's participation and engagement in various forms of motor exercises is often connected to their level of physical fitness. The less frequently students
participate in physical activity, the more likely they are to display a lower level of physical fitness [6, 7].

Children in the fourth year of primary school have the greatest ease of learning new motor habits, even those habits with complex structure(s). This is due to the efficiency of coordination mechanisms and the willingness to engage in physical activity based on locomotor and manual movement. During this period, the need for physical activity enhances the intensity of developing motor coordination abilities [8] and provides for an increase in constitutional abilities (such as speed, power, and agility). A significant growth in constitutional and coordination abilities, together with a well-proportioned body build, determines a high level of physical fitness. Neglecting to develop one of these abilities can contribute to a decrease in physical fitness. It should also be taken into account that these abilities are interrelated and, as Starosta writes, "increasing the level of coordination abilities can help achieve an increase in the level of constitutional abilities" [9, p. 110].

Physical fitness is a very broad term that is related to the state of the entire human body, not just its motor system. The term encompasses all abilities and skills that enable one to effectively perform all kinds of motor tasks [2, 10]. This capacity to master different motor tasks determines one's capability in social life. Moreover, physical fitness in children and youth is one of the indicators that allows us to predict a person's state of health (i.e., predict illnesses or deficiencies in biological development) [2, 11].

Therefore, physical fitness today can be regarded as being in accordance with the aims of engaging in physical activity in the area of health and motor achievements. Wuest and Bucher list the following components related to health: body composition, physical fitness, flexibility, muscular endurance, and muscle strength. Conversely, components related to motor achievements comprise agility, balance, power, reaction time, speed, and coordination [13]. Among the many body characteristics affecting a child's physical fitness, coordination motor abilities are considered to play a very important role. These are defined as "relatively solidified and generalized forms of the course of psychophysical processes of motor regulation. They reflect the complex relationships between neuropsychological processes, which enable efficient control and regulation of human motor actions" [14, p. 13].

Furthermore, these abilities are determined by cognitive processes (perception and thinking). Coordination motor abilities are components of the human structure of motor action, and they play an important role in increasing the effectiveness of the process of physical education at schools [15, 16, 17]. They allow one to acquire, perfect, and stabilize motor skills and to use them consciously and purposefully in various situations and conditions (not just within the school environment). However, the decreased level of coordination skills among students in Polish schools is disturbing [18].

Therefore, all manner of actions should be taken, including developing a methodology for working with a student, which would counteract the regression in the levels of coordination abilities in children, contribute to the correct development of children's physical fitness, and allow us to realize other aims of physical education.

Aim of the study

This study attempts to analyze the effects of the implemented method of conducting physical activities aimed at supporting the development of coordination motor abilities. The study also verifies the effectiveness of using the method. In the 1990s, similar studies were conducted among different age groups participating in various forms of physical activity. Many of these studies showed positive results, thus indicating the possibility of increasing the level of selected coordination abilities or other components of human motor skills as long as a special curriculum was used [19, 20, 21]. In this study, we implemented our special physical education curriculum that supports the development of coordination motor abilities in fourth-year primary school students. Due to our research interests (all of us are members of the Department of Sports Team Games), we only analyze selected coordination motor abilities (spatial orientation, reaction time, kinesthetic differentiation, and motor adjustment) crucial to sports such as basketball, football, volleyball, and handball [22, 23, 24].

The aim of the study was to determine changes in the level of selected coordination motor abilities and individual components of physical fitness in students aged 10 years that occurred as a result of implementing a special physical education curriculum enriched with coordination exercises.

The following research questions were posed:
1. What changes in the level of selected coordination motor abilities and physical fitness have occurred both in students in the experimental groups, who participated in the special physical education curriculum, and in students in the control groups, who participated in a traditional physical education curriculum?
2. Does conducting the special physical education curriculum enriched with coordination exercises affect the level of selected coordination motor abilities and physical fitness in students?

Material and methods

The study used the method of conducting a pedagogical experiment in natural conditions and using the parallel groups technique. Study participants comprised 44 fourth-year students from two classes at the Complex of Public Schools in Wołów and 48 fourth-year students from two classes at Primary School No. 2 in Wołów. The schools were chosen intentionally due to their availability under the cooperation between the Town and Community Council in Wołów and the Faculty of Team Sports Games at the University School of Physical Education in Wrocław. Students in each school were divided into 4 groups, i.e., the experimental group of girls, the experimental group of boys, the control group of girls, and the control group of boys. The students were ascribed to the groups based on their results in physical education and selected coordination motor abilities. The assessment was conducted at the beginning of the school year (October 2010). The experimental groups comprised students who achieved results that were worse than average in tests that determined their level of selected coordination motor abilities [25]. The experimental group comprised 17 girls and 29 boys.

The control group comprised 19 girls and 27 boys. At the beginning of the 2010/2011 school year and at the end of the second semester of the 2010/2011 school year, all the groups underwent tests that determined their level of physical fitness and selected coordination motor abilities. Physical education lessons in all groups were conducted based on the Physical Education Curriculum for the II Educational Stage, Years IV–VI of Primary School [26]. All classes participated in 4 teaching hours of physical education lessons and 2 teaching hours of additional physical activities (sports team games) per week. The experimental groups underwent the special physical education curriculum enriched with exercises that developed coordination motor abilities. During 1 of the 6 teaching hours of physical activities in each week, the experimental groups spent 20 minutes on developing the indicators of selected coordination motor abilities (spatial orientation, reaction time, kinesthetic differentiation, and motor adjustment). Balls for team games were used in these specialist exercises [23]. These exercises were not similar in structure to any of the tests that measured the level of physical fitness or coordination motor abilities. Control groups participated in physical activities conducted according to the traditional curriculum (6 teaching hours per week as well), without the additional, specialist coordination exercises. This allowed us to determine the particular effect of the special physical education curriculum on the level of selected coordination motor abilities and the measured components of physical fitness. Physical activities both in the experimental and in the control groups were conducted by 4 physical education teachers working at the Complex of Public Schools in Wołów and 3 physical education teachers working at Primary School No. 2 in Wołów.

All of them were either nominated teachers or certified teachers and had considerable vocational experience (teaching at schools). In addition, prior to and after the pedagogical experiment, each teacher participated in practical workshops, scientific and methodological conferences, and seminars organized by the Department of Team Sports Games at the University School of Physical Education in Wrocław. The aim of these activities was to explain the study and to make uniform the didactic means used by the teachers (including the method of working with the students). The activities allowed for uniform conditions for conducting the pedagogical experiment in a natural environment (i.e., school).

The experiment conducted in a natural environment involved 2 research measures. The level of physical fitness in children was measured using tests from the ICSPFT International Physical Fitness Test: 50 m sprint, standing long jump, 600 m run, hand strength, flexed-arm hang, 4 x 10 m sprint, sit-ups, and forward bend [27]. Physical fitness was measured in the following way: the student performed the motor test per the description. The result was then converted into points on a scale from 1 to 100 using point charts for particular age groups, as was proposed in 2005 by Pilicz, Przewęda, Dobosz, and Nowacka-Dobosz [27]. The level of students’ physical fitness was calculated by adding their results from each test [27].

Coordination motor abilities were measured with the following tests: running to a ball, which assessed the indicators of the spatial orientation ability; stopping a rolling ball, which assessed reaction time; standing long jump at 50% capacity, which assessed kinesthetic differentiation; and forward and backward standing long jump, which assessed motor adjustment [14].

Analysis of variance (ANOVA) was applied to the results of the research. ANOVA tests the significance of
differences between mean values that contribute to the observed effect [28]. The Least Significant Difference (LSD) test was also used. It provided information on factorial effects and interactive differences occurring in the repeated measurements experiment. Only the differences occurring within and between the experimental and control groups from a given school were calculated. [18].

Analysis

Based on the results of the spatial orientation tests, it was found that students in all assessed groups (experimental and control) improved their scores. The results showed that mean running time decreased in the second measurement compared to the first measurement in all groups.

In the Complex of Public Schools in Wołów, the first measurement found statistically significant differences between the experimental and control groups of girls, as well as the experimental and control groups of boys (Figure 1).

The mean running time of girls in the experimental group amounted to $\bar{x} = 22.76$ s, which was 2.71 s longer than in the control group (the difference was statistically significant, with $P < 0.05$). Similarly, the mean running time of boys in the experimental group was 1.9 s longer than in the control group and equaled $\bar{x} = 21.73$ s (the difference was statistically significant, with $P < 0.001$).

After the pedagogical experiment, changes in spatial orientation were statistically significant in all studied groups (Figure 1). The greatest difference between the first and second measurement was found in the experimental group of boys and equaled $\Delta \bar{x} = 2.2$ s ($P < 0.001$). On the other hand, the control group of boys improved their result by 1.77 s ($P < 0.001$) compared to the first measurement ($\bar{x} = 19.83$ s). Running time during the second measurement in the experimental group of girls equaled $\bar{x} = 21.13$ s and was 1.63 s shorter compared to the first measurement ($P < 0.05$).

Statistically significant differences in the running to a ball test (which assessed spatial orientation ability) were observed between the experimental and control group of girls from Primary School No. 2 in Wołów during the first measurement (Figure 2). Mean running time in the experimental group amounted to $\bar{x} = 22.62$ s, which was 2.5 s longer than in the control group (the difference was statistically significant, with $P < 0.05$). In contrast, no statistically significant difference was observed between the experimental and control groups of boys.

All the experimental and control groups in Primary School No. 2 in Wołów, similar to the groups in the Complex of Public Schools in Wołów, considerably improved their running time (the difference was also statistically significant). The greatest difference between the first and second measurements was found in the experimental group of girls and amounted to $\Delta \bar{x} = 1.42$ s ($P < 0.01$). Their running time during the second measurement was $\bar{x} = 21.20$ s (Figure 2). Mean running time in the control group of girls was 1.23 s shorter ($P < 0.05$) compared to the first measurement. Despite a lower increase in spatial orientation in the control group of girls, the difference between their result and the results of the experimental group in the second measurement remained statistically significant ($P < 0.05$).
The experimental group of boys achieved a result of $\bar{x} = 18.99$ s, which was 1.03 s better ($P < 0.05$) than during the measurement at the beginning of the school year. A considerable change was also observed in the experimental group of boys, whose mean running time in the second measurement was also shorter by 1.03 s ($P < 0.05$) and equaled $\bar{x} = 18.49$ s. Despite the beneficial changes among boys in both studied groups, no statistically significant differences between their results were found at the end of the school year.

Analysis of the results of the stopping a rolling ball test, which indicated reaction time, showed both positive and negative changes in the studied groups. In the Complex of Public Schools in Wołów, no statistically significant differences were observed during the first measurement between the experimental and control groups of girls, as well as between the experimental and control groups of boys (Figure 3), with the exception of the control group of boys, who showed considerably worse results, achieving $\bar{x} = 80.15$ cm during the first measurement and $\bar{x} = 95.54$ cm during the second measurement (the difference between the results was statistically significant, with $P < 0.01$). Changes in reaction time were insignificant for all other groups in the school (Figure 3). Furthermore, no statistically significant differences were found at the end of the school year between the groups of boys and between the groups of girls.

![Figure 3](image.png)

Figure 3. Results of the stopping a rolling ball test achieved by the students of the Complex of Public Schools in Wołów

In Primary School No. 2 in Wołów, statistically significant differences between the groups of boys were observed only during the first measurement ($P < 0.01$). The experimental group of boys achieved the result of $\bar{x} = 146.71$ cm at the beginning of the school year, which was 17.33 cm worse than the boys in the control group (Figure 4). All groups in the school showed beneficial changes in reaction time (Figure 4). The experimental group of boys showed the greatest difference (statistically significant, with $P < 0.05$) between the first and second measurement, amounting to $\Delta \bar{x} = 27.5$ cm.

![Figure 4](image.png)

Figure 4. Results of the stopping a running ball test achieved by the students of Primary School No. 2 in Wołów

Furthermore, the control group of boys achieved the best result in the school, amounting to $\bar{x} = 114.31$ cm in the second measurement. The group improved their result by 15.07 cm (the difference was statistically significant, with $P < 0.01$). The control group of girls improved their result during the second measurement by 13.11 cm ($P < 0.05$) compared to the beginning of the school year (Figure 4).

The results of the stopping a rolling ball test achieved by the studied groups in the second measurement showed no statistically significant differences between the groups.

To acquire information on the level of kinesthetic differentiation in the students, the percentage value of accuracy of strength differentiation (RS) during a long jump was calculated according to the formula proposed by Raczek [14]. The students attempted to achieve a result equal to 50% of their maximal long jump distance; managing to do so indicated the highest possible accuracy of strength differentiation (RS = 100%).

The results of the standing long jump at 50% capacity test showed that all control groups performed better than the experimental groups at the beginning of the school year. The control group of girls attending the Complex of Public Schools in Wołów achieved the result $\bar{x} = 95\%$ in strength differentiation, which was 51%
better than the experimental group (the difference was statistically significant, P < 0.001). Similarly, strength differentiation of the control group of boys amounted to $\bar{x} = 91\%$ and was 46% better (P < 0.001) than in the experimental group.

The greatest changes (beneficial and statistically significant) among the students of the Complex of Public Schools in Wołów were observed in both experimental groups (Figure 5).

![Figure 5. Results of the standing long jump at 50% capacity test achieved by students of the Complex of Public Schools in Wołów](image)

Accuracy of strength differentiation in the experimental group of girls improved by 41% (P < 0.01) during the second measurement and amounted to $\bar{x} = 86\%$. Conversely, the experimental group of boys achieved the result $\bar{x} = 91\%$, which was 46% better than during the first measurement (the difference was statistically significant, P < 0.001). Both experimental groups displayed considerable changes in the level of kinesthetic differentiation compared to other studied groups.

An analysis of the results achieved by the control groups in the Complex of Public Schools in Wołów found a statistically significant decrease in kinesthetic differentiation in boys. Their accuracy of strength differentiation amounted to $\bar{x} = 72\%$ during the standing long jump, which was 19% lower (P < 0.001) compared to the beginning of the school year (Figure 5).

The standing long jump at 50% capacity test found no statistically significant differences between the experimental and control groups in Primary School No. 2 in Wołów during the first and second measurement.

Moreover, no statistically significant differences between the first and second measurement were observed in any of the studied groups. The control groups performed best during the test (Figure 6).

![Figure 6. Results of the forward and backward standing long jump test achieved by students of the Complex of Public Schools in Wołów](image)

To acquire information on the level of motor adjustment of students, the difference between the distance of the maximal forward jump on both legs and the distance of the maximal backward jump on both legs was calculated [14]. The lower the difference, the greater the student's level of motor adjustment.

The experimental group of girls in the Complex of Public Schools in Wołów achieved the result $\bar{x} = 90.80\, \text{cm}$ during the assessment of motor adjustment, which was 13.68 cm better than in the control group (the difference was statistically significant, P < 0.05). The assessment found no statistically significant differences between the experimental and control group of boys (Figure 7).

![Figure 7. Results of the standing long jump at 50% capacity test achieved by students of Primary School No. 2 in Wołów](image)

During the second measurement, the experimental group of girls achieved the result $\bar{x} = 75.30\, \text{cm}$, which was 15.5 cm better than during the first measure-
ment (the difference was statistically significant, with $P < 0.01$). On the other hand, the experimental group of boys in the same school performed considerably worse during the second measurement (by 10.46 cm, $P < 0.01$), achieving the result $\bar{x} = 88.15$ cm (Figure 7). No statistically significant changes in the level of motor adjustment were found in the control groups.

Almost all the groups performed the forward and backward standing long jump test worse at the end of the school year compared to the beginning of the school year (Figure 7). Furthermore, no differences were observed between the experimental and control groups.

Similarly, statistically significant, negative changes were found in the experimental group of boys in Primary School No. 2 in Wołów (Figure 8). Their result after participating in the special physical education curriculum with additional coordination exercises amounted to $\bar{x} = 85.14$ during the second measurement and was 10.64 cm worse ($P < 0.01$) compared to the first measurement.

No statistically significant differences in the level of motor adjustment were found in the control groups.

Almost all the groups performed the forward and backward standing long jump test worse at the end of the school year compared to the beginning of the school year (Figure 7). Furthermore, no differences were observed between the experimental and control groups. Similarly, statistically significant, negative changes were found in the experimental group of boys in Primary School No. 2 in Wołów (Figure 8). Their result after participating in the special physical education curriculum with additional coordination exercises amounted to $\bar{x} = 85.14$ during the second measurement and was 10.64 cm worse ($P < 0.01$) compared to the first measurement.

Statistically significant, beneficial changes were observed at the end of the school year in the experimental and control group of girls (Figure 9). The experimental group of boys improved their result by 36.61 points (the difference was statistically significant, $P < 0.01$), achieving $\bar{x} = 393.69$ points. Conversely, the experimental group of girls improved their result by 43.38 points (the difference was statistically significant, $P < 0.01$) at the end of the school year, achieving $\bar{x} = 443.88$ points. The control group of girls improved and achieved the result $\bar{x} = 415.00$ points during the second measurement; they improved their previous score by 32.30 points (the difference was statistically significant, $P < 0.05$). Despite the significant and insignificant changes that occurred in the level of physical fitness in students attending the Complex of Public Schools in Wołów who were assessed with the IPFT, no statistically significant differences between the studied groups of girls and boys were found at the end of the school year.

On the other hand, in Primary School No. 2 in Wołów, statistically significant differences between the results of the experimental and control groups of girls were already observed during the first measurement. The experimental group of girls achieved the result $\bar{x} = 387.33$ points (Figure 10), which was 108.22 points better compared to the control group (the difference was statistically significant, $P < 0.001$). No statistically
significant differences were found between the first and second measurement in the experimental and control groups of boys, although the experimental group performed better than the control group.

Only the experimental and control group of girls attending Primary School No. 2 in Wołów showed significant changes in the level of physical fitness at the end of the school year. The experimental group of girls improved their result by 32.78 points, and the difference between the measurements was statistically significant ($P < 0.05$). The control group of girls achieved the result $\bar{x} = 347.11$ points at the end of the school year, which constituted an improvement of 68 points (the difference was statistically significant, $P < 0.001$). Statistically significant differences were also observed between the experimental and control group of girls as well as boys during the second measurement. The difference decreased slightly between the experimental and control groups of girls and amounted to $\Delta \bar{x} = 73$ points ($P < 0.05$); between the groups of boys it increased by 53.21 points ($P < 0.05$).

**Discussion and summary**

The obtained research results show that all experimental groups that participated in the special physical education curriculum enriched with coordination exercises and control groups in both schools (except the control group of girls in the Complex of Public Schools) underwent beneficial, statistically significant changes in their level of spatial orientation. It is difficult to assess the influence of the special curriculum on the participants’ spatial orientation. It seems that the influence was similar to that of the traditional physical education curriculum. The increase in levels of spatial orientation was most likely due to the students’ physical development and not to their participation in the curriculum. As an ability, spatiotemporal orientation is affected by special coordination exercises only to a small degree, as stated earlier by Gierczuk and Sadowski [29] and as confirmed by this study.

The results of the stopping a rolling ball test that assessed reaction time indicate significant changes only in both experimental groups and in the control group of boys from Primary School No. 2 in Wołów. In contrast, no significant changes in reaction time were found for most students of the Complex of Public Schools (except for the control group of girls).

It seems that the results may have been affected by teachers, who paid attention to accuracy and speed of the performed motor exercises. Throughout the course of the pedagogical experiment, we also considered information provided by the teachers to the students and the students’ attitudes during motor exercises. It seems that these factors could have influenced the results obtained during the measurements at the end of the school year.

All experimental groups improved their results in kinesthetic differentiation. However, the only beneficial and statistically significant changes occurred in students of the Complex of Public Schools. Furthermore, negative changes in kinesthetic differentiation were also observed. The control group of boys from the Complex of Public Schools performed worse at the end of the year than they did during the first measurement. The results of the kinesthetic differentiation assessment allow us to draw a cautious conclusion that the ability was affected by the special physical education curriculum enriched with coordination exercises. Similar results were also obtained by Gierczuk and Sadowski in 2008 in a study with young wrestlers [29] and by Tsetseli, Malliou, Zetou, Michalopoulou, and Kambas [30], who analyzed the performance of tennis players. Nevertheless, the results of the kinesthetic differentiation assessment should be analyzed with care, as the experimental groups did not perform well during the first measurement. This may have been because the children did not understand the motor exercise they were asked to perform.

The results of the motor adjustment test indicated beneficial changes only in the experimental group of girls from the Complex of Public Schools in Wołów. In all other groups, the changes were negative. However, the obtained results did not confirm
those of the aforementioned authors (Gierczuk and Sadowski), who found that their special physical education curriculum, aimed at developing indicators of coordination motor abilities, affected participants’ motor adjustment [29].

It seems that the individual coordination motor abilities assessed with each test are the dominating components; however, this does not rule out the involvement of other abilities, including individual constitutional abilities per the ‘domination of the surface’ or the ‘domination of components’ principles [18]. This may have affected the performance of the study participants during assessments of individual coordination abilities. Even though the students’ performances during the assessments of spatial orientation and kinesthetic differentiation improved, results were also obtained that indicated a decrease in performance during other assessments, i.e., motor adjustment and reaction time. This may be tied to interrelations between energy factors and information factors, as described by Raczek [18] and Mynarski [31]. Assessments of spatial orientation and reaction time involve indicators of speed and agility that correlate negatively with indicators of strength (including the functional strength of legs). The latter ability manifested itself during assessments of motor adjustment and kinesthetic differentiation.

The IPFT was used to assess changes in the level of physical fitness of the study participants. Only point values that constituted the sum of points obtained during each IPFT were used in the analysis. Changes in individual components of physical fitness were not analyzed due to the scope of the material. The special physical education curriculum enriched with coordination exercises showed beneficial changes of the level of physical fitness in the experimental and control groups, as measured using the IPFT. The results of the IPFT obtained by the experimental and control groups do not allow us to state unambiguously which of them performed better after the one-year experiment. In the Complex of Public Schools, the experimental groups, as well as the control group of girls, showed beneficial, statistically significant changes in the level of physical fitness. On the other hand, in Primary School No. 2, only the experimental and control group of girls showed statistically significant changes in physical fitness. For these reasons, we can cautiously surmise that conducting the special physical education curriculum enriched with coordination exercises may have positively affected the changes in each component of physical fitness. Nonetheless, we cannot rule out the influence of other factors (such as the teacher motivating the students, the role of the student in a group, and the way students spend their free time after school), which may affect changes in the level of individual components of physical fitness and selected coordination motor abilities. However, it is certain that conducting the coordination exercises does not create harmful situations that would result in a decrease of physical fitness.

The analysis of the study’s results also showed the significance of other factors affecting the students’ physical fitness. Even though the conditions for conducting the pedagogical experiment were similar (the same number of teaching hours, a comparable number of students in each class, similar school backgrounds, the same curriculum, and the same set of coordination exercises), the observed changes in the level of physical fitness and selected coordination motor abilities were different. This may have been affected, for instance, by the students participating in various forms of physical activity outside school or the individual differences in motor development of each child, as well as their age and speed of development [32, 33].

In résumé, it was found that all experimental groups improved their performance in selected coordination motor abilities after participating in the special physical education curriculum enriched with coordination exercises. Statistically significant changes were observed in the level of spatial orientation in all experimental groups (in both schools). On the other hand, the results of reaction time, kinesthetic differentiation, and motor adjustment tests differed between the school environments. The control groups more often showed negative or insignificant changes in the development of the studied coordination motor abilities.

It is assumed that systematic engagement in a 20-minute set of coordination exercises can cause changes in the level of selected coordination motor abilities. However, this should be a long-term process, rather than a sporadic or periodic engagement done at the request of the teacher.

The experimental groups (of boys as well as girls) who participated in the special physical education curriculum enriched with additional coordination exercises improved their results of the IPFT at the end of the second semester. Similar changes were also observed in the control groups. For these reasons, we can assume that conducting the special physical education curriculum enriched with coordination exercises positively affected changes in individual components of physi-
cal fitness, similar to conducting a traditional physical education curriculum. This leads to the conclusion that conducting the special physical education curriculum enriched with coordination exercises in not the only factor influencing the development of physical fitness in children aged 10 years.

Acknowledgements

We wish to thank the principals and teachers of physical education at the Complex of Public Schools and Primary School No. 2 in Wolów for their assistance in conducting this study.

LITERATURE

Physical fitness of children aged 10 years participating in physical education classes enriched with coordination...