IMPACT OF THE EXERCISE PROGRAMME BASED ON FLOWIN CONCEPT AND IMPLEMENTED IN PHYSICAL AND SPORTS EDUCATION CLASSES ON FUNCTIONS OF THE POSTURAL MUSCLE SYSTEM

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Original scientific paper

Abstract
This article presents the partial task and its aim, focused on the targeted workout programme consisting of Flowin exercises. The workout programme was implemented among the pupils of the 8th class in physical and sports education classes and it should develop into the basis for innovations in this school subject. We recorded the significant changes at 5% level among both the girls and the boys. Initial and also final measurements revealed that the both experimental groups most frequently suffered from shortening of the knee flexors. The girls reached better changes in functions of postural muscles. However, the boys had bigger differences between averages of initial and final measurements. Furthermore, we would like to point out the benefits of the exercise programme within physical and sports education. This programme has a positive impact on functionality of the postural muscle system, and at the same time, it prevents improper body posture. What is more, such a programme could increase motivation and arouse interest in sports activities among teenagers. Experimental verification of the "intensification factor" in physical and sports education classes at elementary schools means the knowledge and a starting point for theory and practice of the physical and sports education. The article is the part of the project called: ,,The article is a part of the grant research task VEGA No. 1/0757/12 titled Reactive and Adaptation Indicators of Changes in Physical and Mental Abilities of Sportsmen in Connection to Biorhythms with Periods of Different Lengths."
Key words: *exercise programme, Flowin concept, muscle system, pupil*

INTRODUCTION

The Slovak educational system had followed the outdated Elementary and Secondary Education Act 29/1984 until September 1, 2008. As a result, the quality of education was decreasing and this tendency was confirmed by PISA and PIRLS international assessment results. The educational contents and syllabi did not meet the labour market requirements (http://www.minedu.sk).

The school year 2008/2009 saw the beginning of the educational reform based on the Education Amendment Act 245/2008. The Slovak school system was newly defined and the educational system was adapted to the ISCED international standards. What is more, the two-level educational model was introduced. This model brings schools more opportunities for adapting to basic needs of the region and their own possibilities. The transformation of the educational system in Slovakia has been continuing for the fifth year and it also concerns physical education. The previous subject physical education is now called *physical and sports education* and it was included in a new educational field called *Health and Exercise* with the following main modules: (Antala, 2009):

- *health and its disorders,*
- *healthy lifestyle,*
- *physical abilities and performance, ,*
- *sports activities within an exercise schedule,*

which provide teachers and pupils with an opportunity to prefer activities aimed at health, good performance as well as arousing interest in exercise (Antala, Labudová, 2008). This should result in prevalence of diversified innovative syllabus of school classes, as Bendíková (2012) states. As far as the 2008 school reform is concerned, it is necessary to point out that the aim of physical and sports education deflects from the performance-oriented classes to health-oriented classes and development of certain values and attitudes (Antala, Labudová, 2008).

The syllabi of physical and sports education is now focused on the value of health and pupils' active attitude towards their own health (Bendíková, 2011). In this connection, we would like to emphasize the fact, which is confirmed by WHO (2010) as well, that hypokinesis is defined as an independent risk factor which contributes to development of chronic non-infectious diseases (lifestyle diseases). The number of these diseases has multiplied in the past decade (obesity, diabetes, allergies, asthma, vertebrogenic disorders, neuroses, cardiovascular disorders, etc.) and this increase also resulted in disorders and impaired health among school population in elementary and secondary schools (Bousquet, 1998; Bulas, 2004; Hruškovič, 2004; Kayserová, 2004; Čižmár, 2006; Dukát, 2006).

Human health also includes the muscular and skeletal systems disorders, which are on the increase particularly among school population. It is necessary to point out vertebrogenic disorders of functional and structural character, which are related to incorrect body posture and muscle imbalance. Improper workout schedule with a striking disproportion between exercise and postural activities, where muscles are loaded more statically than dynamically, exists already among children of preschool age (Javůrek, 1990; Thurzová, 1991; Thurzová et al., 1993, Riegerová, 2004), then continues to exist among school population (Přidalová, 2000; Pleidelová et al. 2002; Vargová, Veselý, 2002; Kania–Gudzio, Wiernicka, 2002; Kostencka, 2007; Kopecký, 2005; Kováčová, Medeková, 2005; Kováčová, Paugschová, 2005; Medeková, 2006; Kanasová, 2004; Vařeková, Vařeka, 2005; Bartík, 2007; Kokavec, Novorolský, 2007; Kopecký, Ely, 2007; Majerík, 2009; Medeková, Bekö, 2009; Medeková, Majerík, 2009; Jurášková, Bartík, 2010; Kanásová, Šimončičová, 2011; Prachárová, 2011; Adamčák, Kozaňáková, 2012) and still persists in adulthood (Bendíková, 2007).

Musculoskeletal system disorders affect the musculoskeletal system as a whole (Snook, 2004). They typically manifest as functional disorders which develop a chain within the musculoskeletal system. One change causes another and the functional disorders are generalized at several levels (Hornáček, 2004; Velé, 2006). Consequently, the muscle imbalance affects body posture as well as muscle coordination. According to the postural ontogenesis rules, the upright body posture depends on the contraction, e. i. joined activity of antagonistic muscles. This is true for the entire spine. The spine extensors are evenly activated by the neck deep flexors and muscle balance between diaphragma, abdominal muscles and bottom of the pelvis, which stabilise the spine from the front by means of intra-abdominal pressure. The muscle stabilisation function is connected with the quality of control processes in the central nervous system. Disturbed muscle balance is often controlled by the central nervous system, which results in muscle imbalance during stabilisation function of muscles in action. As a result, movement requires excessive muscle power and more active muscles than it is necessary during goal-directed exercise (Rýchliková, 1997, Buran, 2002; Malátová, Rokytová, 2007).
The disorder of agonistic-antagonistic synergy, caused by a local disorder or local overload, results in a disturbed static function of the muscle. The static muscles undergoing heavy loading shorten and dynamic muscles which are not loaded weaken due to reciprocal inhibition. This all causes muscle imbalance, as Janda (1982), Lewit (1996) state. Within reciprocal inhibition, activation of one agonistic-antagonistic muscle inhibits its antagonist. Muscle imbalance (shortened static muscles and weakened dynamic muscles) results in changes of starting positions in all joints, muscle tension and fascia as well as the pressure on joint surface. Limited mobility (flexibility) of joints and spine may cause a lot of functional problems. The central nervous system receives wrong information from the skin receptors, hypodermis, muscles and joints and, accordingly, it develops a movement pattern as well as order and power of contraction of individual muscles. During proper movement, the muscles activate in a correct order. If, however, muscles are imbalanced and receive improper orders (changes in activation order, lack of a particular muscle activation in the chain), the entire movement is disturbed. Such a movement is imprecise, slower and uneconomic. Therefore, it is more demanding for the body and gradually results in fatigue and damage of muscle insertions, ligaments, joints and also intervertebral discs (Gúth, 2006; Velé, 2006).

The aim is to find out how the applied exercise programme, which includes also Flowin fitness concept, affects functionality of postural and phasic muscles among the pupils of the 8th class of one particular elementary school. We assume that application of the exercise programme, which includes also Flowin concept, will improve the functionality of particular postural muscles among pupils, with intersexual differences between girls and boys in the particular class.

METHODS

The experimental group was comprised of the pupils from one elementary school in the town of L. Mikuláš. At the beginning, the group had 72 pupils of the 8th class. However, only 66 pupils were included in the final assessment. What is more, six pupils were excluded because they did not pass the entrance tests and also due to their frequent absence in physical and sports education lessons. The Chart 1 presents the basic characteristics of the group.

Table 1. Characteristics of the group (n = 66)

Boys/n	Body height/cm		Body weight/kg		Average age
classes/indicators	input	output	input	output	
8. A (n = 11)	152,4	154,6	43,5	45,7	13,84
8. B (n = 11)	158,3	162,1	48,2	52,8	13,18
8. C (n = 12)	165,6	169,3	53,7	56,3	13,91
Girls/n					
8. A (n = 11)	153,1	160,3	42,3	44,9	13,92
8. B (n = 11)	158,2	165,2	47,5	50,3	13,86
8. C (n = 10)	162,9	167,8	52,4	54,2	13,80

In the school year 2011/2012, we did the research at the selected elementary school. This research was based on implementation of the exercise programme, which included Flowin concept, in physical and sports education classes for the period of 3 months, including three 45-minute lessons a week. The pupils underwent the initial and final examinations of their musculoskeletal systems in the clinic in L. Mikuláš, under supervision of the physiotherapy specialist and the examinations were done using the method Jaroš – Lomíčka (In Hošková, Matoušová, 2005). For processing of the qualitative and quantitative data, we used the basic mathematical statistics methods, percentage frequency analysis, standard deviation (s), arithmetic average ($\bar{x}$), median (Me), modus (Mo). Statistical significance of averages of postural muscles function with the use of two intra-subject factors: sex, class and one inner-subject factor: time (before and after experiment) was verified by the analysis called MANOVA/ANOVA at 5% ($p < 0,05$) level of statistical significance. Furthermore, we also used logical analysis and synthesis together with inductive and deductive procedures as well as comparison and generalization. All the data were processed with regard to sex differences.

RESULTS AND DISCUSSION

Initial examinations performed within our research recorded lower percentage of shortened levator scapula muscle among the boys than among the girls. Shortening of this muscle was recorded with 17.43% of the boys and 23.72% of the girls. (Table 2). The boys had better results of the final examinations, where only 9.81% of them had the shortened levator scapula muscle, whereas 11.80% of the girls still demonstrated shortening. The difference between initial and final measurements among the boys was not statistically significant (0,161 > 0,05), whereas the difference among the girls 11,50 % meant the statistical difference at 5 % level (0,046 < 0,05).

Table 2 M. levatore scapulae (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	17,43%	9,81%	7,62%	0,161♦	Statistically insignificant	Statistically insignificant
Girls (n=32)	23,72%	11,50%	12,22%	0,046*		

Legend: *statistically significant difference $p < 0,05$, ♦ statistically insignificant difference $p > 0,05$

Similarly, the initial examinations proved that fewer boys had shortened M. trapezius pars superior in comparison to the girls. The boys' initial shortening was 13,71% and final shortening only 7,25%. The difference between initial and final tests was statistically insignificant (0,159 > 0,05). The girls' initial shortening was 21,46 %. However, thanks to the targeted exercise programme, which included Flowin concept, this shortening decreased to 7,93 %, with the difference 13, 53 %, which meant the statistical significance at 5 % level (0,043 < 0,05) (Table 3). The trapezius muscle shortening resulted in horizontal posture of shoulders. What is more, our research found out that the pupils had shortened levator scapula muscle, the sign of which were prominent shoulder blades, where the head dropped between the shoulders. In this connection, it is necessary to point out the fact that excessive loading of the upper part of the trapezius muscle caused the shortening of the levator scapula muscle as well. It was shortened by the same difference as the trapezius muscle – pars descendens. Lewit (1996), Gályová (1997), Rýchliková (1997), Velé (2006) explain the same difference by the similar function of both muscles and one-sided load of these muscles during elevation of the blade

bone and shoulder joint. This condition is also caused by sedentary work with prevalence of the right hand usage. Shortened trapezius muscle– pars descendens and levator scapula muscle resulted in insufficient head bending among all the pupils during initial measurements in comparison to final measurements (Bendíková - Stacho 2010).

Table 3. M. trapezius pars superior (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual Differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	13,71%	7,25%	6,46%	0,159♦	Statistically insignificant	Statistically insignificant
Girls (n=32)	21,46%	7,93%	13,53%	0,048*		

Legend : *statistically significant difference p < 0,05, ♦ statistically insignificant difference p > 0,05

The knee flexors (m. biceps femoris, m. semitendinosus and m. semimembranosus) were shortened most frequently in our research. The research done by Kanásová (2004) also confirms the high prevalence of shortened knee muscles. Our research has found out that 68.56% of the boys and 53.78% of the girls had the shortened knee flexors after initial examinations. Thus, the difference between the boys and girls was 14.8%. However, we were able to decrease the frequency of shortened knee flexors by 19.44% thanks to the workout programme based on Flowin exercise. The value of final tests among the bouys was 49,12 %, which meant the statistical significance at 5 % significance level (p < 0,05) (Chart 4). The exercise programme had a positive impact also on the girls. Their muscle shortening decreased by 19,17%, which meant the statistically significant difference at 5 % significance level (0,013 < 0,05) (Chart 4). It is important to stress that significant shortening of knee flexors influences dynamic and static functions of lower limbs, pelvis and the waist, which significantly influences quality of the functional muscle chain (Kolář, 2001; Velé, 2006).

Table 4. Knee flexors (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between groups V1 and V2
Boys (n=34)	68,56%	49,12%	19,44%	0,025*	Statistically insignificant	Statistically insignificant
Girls (n=32)	53,78%	34,61%	19,17%	0,013*		

Legend: *statistically significant difference p < 0,05, ♦ statistically insignificant difference p > 0,05

Hip joint flexors (m. rectus femoris, m. iliopsoas a m. tensor fasciae latae) were the on the second place as far as the frequency of shortening after initial measurements is concerned. Almost half of the boys had shortened hip joint flexors at initial measurements. However, final measurements revealed shortening only among 17,22% of the boys. The difference between initial and final measurements was 28,89%, which was the most significant improvement of all shortened muscles. This improvement meant also the statistically significant difference at 5 % significance level (0,002 < 0,05) (Table 5). Initial tests revealed that 40,25% of the girls had shortened hip joint flexors and after final measurements, 18,55% of the girls had this problem, which means that the girls' improvement was a bit worse than that of the boys. Their improvement was 21,70% and it also meant a statistically significant difference at 5 % significance level (p < 0,05) (Table 5).

According to Dostálová (1999), shortening of the above-mentioned postural muscles contributes to the pelvis anteversion and enlargement of the waist lordosis. Janda (1982) states that shortening of the hip joint flexors may cause changes in the walking stereotype, resulting in overload of lumbar and sacral spinal segments accompanied by pathological changes in the lumbar spine and pelvis.

Table 5. Hip joint flexors (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	46,11%	17,22%	28,89%	0,002*	Statisticall insignifica nt	Statisticall. insignificant
Girls (n=32)	40,25%	18,55%	21,70%	0,005*		

Legend: *statistically significant difference p < 0,05, ♦ statistically insignificant difference p > 0,05

Initial tests revealed shortening of the quadratus lumborum muscle among 35,74% of the boys. The exercise programme helped decrease this percentage by 15,81%. This difference was statistically significant at 5 % significance level (0,045 < 0,05) (Table 6). More girls than boys had shortened quadratus lumborum muscle (40,16%). However, final measurements showed decrease to 11,23%. Therefore, the girls' difference between initial and final measurements was 28,93%. This improvement meant the statistically significant difference at 5 % significance level (0,002 < 0,05) (Table 6).

Table 6. Quadratus lumborum (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	35,74%	19,93%	15,81%	0,045*	Statistically insignificant	Statistically insignificant
Girls (n=32)	40,16%	11,23%	28,93%	0,002*		

Legend: *statistically significant difference p < 0,05, ♦ statistically insignificant difference > 0,05

All the pupils had symmetrical shortening of the erector spinae muscle detected from the tested pairs of postural muscles. The back extensor was shortened among 35,16% of the boys, which was 19% more than among the girls. Decreased flexibility of the waist part of the spine was characterized by a curve that was not continual. This curve clearly showed that paravertebral muscles in this area were weakened. Thanks to the exercise programme based on Flowin concept we managed to decrease the frequency of the shortened erector spinae muscle to 12,56 %, where the difference between initial and final tests was 22,51 % and the statistically significant difference was at 5 % significance level (p < 0,05) (Table 7).

Table 7. M. erector spinae (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 a V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	35,16%	12,65%	22,51%	0,013*	Statistically insignificant	Statistically insignificant
Girls (n=32)	17,48%	5,67%	11,87%	0,044*		

Legend: *statistically significant difference p < 0,05, ♦ = statistically insignificant difference p > 0,05

The frequency of the shortened back extensor among the girls was 17,48% after initial tests. The girls reached the statistically significant difference of final measurements at 5 % significance level (p<0,05) (Table 7) – 5,67% of the girls had shortened erector spinae muscle. We find this result positive in term of the prevalence of pains in the lumbar spine caused by shortening of this group of muscles.

The fact that we discovered the shortening of the pectoralis major muscle confirms the existence of a relaxed sitting position among pupils, which is characterized by rounded shoulders, the funnel chest among six pupils and enlarged thoracic kyphosis among 14% of the pupils after initial measurements. The extent of this muscle shortening did not cause pathologically prominent shoulder blades, which is both aesthetic and health problem. Initial measurements detected that more boys (31,25%) than girls had shortened pectoralis muscle. After final measurements we recorded the difference 8,03 %, which was statistically significant (p > 0,05). Kanásová (2004) discovered shortening of this muscle among

58,33% of the boys at the second degree of an elementary school.

The situation with the girls was different. During initial measurements, we recorded 19,42% shortening of the pectoralis muscle and the exercise programme helped decrease this percentage to 7,48%. The difference between initial and final measurements was 11,94%, which meant the statistically significant difference of averages at 5 % significance level (0,045 < 0,05) (Table 8).

Table 8 M. pectoralis major (n=66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 a V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	31,25%	23,22%	8,03%	0,161♦	Statistically insignificant	Statistically insignificant
Girls (n=32)	19,42%	7,48%	11,94%	0,045*		

Legend: *statistically significant difference p < 0,05, ♦ statistically insignificant difference p > 0,05

Thigh adductors were the third least shortened muscles within our experimental group. Initial tests revealed that 9,78% of the boys and 5,26% of the girls had shortened thigh adductors. The exercise programme helped decrease these levels to 2,59% among the boys and 1,26% among the girls. The difference between initial and final measurements was statistically insignificant (0,161; 0,159 > 0,05) with both sexes (Table 9).

Table 9. Thigh adductors (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 a V2	Statistical significance of difference	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	9,78%	2,59%	7,19%	0,161♦	Statistically insignificant	Statistically insignificant
Girls (n=32)	5,26%	1,26%	4,00%	0,159♦		

Legend: * statistically significant difference p < 0,05, ♦ statistically insignificant difference p > 0,05

Initial tests revealed that 32,28% of the boys had the shortened triceps surae muscle. Our findings corresponded with the results reached by Kanásová (2004), where more than 26% of pupils had this problem. After final measurements and after completing the exercise programme based on Flowin concept, when most of the pupils were able to do knee bend standing on the entire surface of their feet, 16,65% of the boys had the shortened triceps surae muscle, which meant the improvement of the functional condition of this muscle (p < 0,05). The number of the girls suffering from shortening of this muscle was not so significant. Initial tests results were 15,23% and after final tests only 7,34% of the girls has shortened triceps surae muscle (Table 10). This difference was not statistically significant (p > 0,05). What is more, mutual effect and interconnection of these muscle groups (triceps surae muscle and knee flexors) was confirmed. Proper function of the triceps surae muscle contributes to flexion in the knee joint during walking and it helps to keep proper posture of the shank.

Table 10. M. triceps surae (n = 66)

Experimental group	Initial measurement V1	Final measurement V2	Difference between V1 and V2	Statistical significance of differences	Intersexual differences between V1 and V2	Differences between classes V1 and V2
Boys (n=34)	32,28%	16,65%	15,63%	0,045*	Statistically insignificant	Statistically insignificant
Girls (n=32)	15,23%	7,89%	7,34%	0,079♦		

Legend: *statistically significant difference p < 0,05, ♦ statistically significant difference p > 0,05

According to Velé (2006), shortening of these muscles among children may be visible when they walk on front part of their feet. This kind of walking may have an effect not only on other

orthopaedic disorders (pelvic tilt, improper curvature of the waist spine in the side and front and back direction), but also on the entire health condition and locomotor skills of a child.

PRACTICAL APLICATION

By monitoring the functions of postural and phasic muscle systems and by application of the exercise programme based on Flowin concept in physical and sports education classes, we recorded positive changes after 3 months. These changes in monitored indicators were positive with both the girls and boys and thus our hypothesis was confirmed. The results of all final tests showed improvement which meets the standard according to Labudová, Thurzová (1992). Significant changes at 5 % significant level were recorded among both the boys and the girls in the following areas: knee flexors, hip joint flexors, the m.quadratus lumborum muscle and the erector spinae muscle. The girls reached significant improvement at 5% significance level in the following muscle groups: the m.pectoralis muscle, the m.levatore scapule muscle and the upper part of the trapezius muscle, whereas the boys reached the significant improvement at 5% significance level in the surae triceps muscle. All in all, the girls reached the better results. In this connection, we would like to emphasize that changes in functions of postural muscles are also connected with better dynamics of the spine among both the girls and the boys.

The stated initial values and the condition of postural muscles among school population are alarming even though we cannot generalize them. We should understand them as the research basis. Furthermore, we assume that improvements after final measurements were brought about by the syllabi of physical and sports education classes as well as properly implemented methods, the quality and extent of which were sufficient.

Our exercise programme based on Flowin concept proved to be appropriate within physical and sports education classes and it contributed to improvement of the postural muscle systems among the experimental group of pupils. The specific character of the programme proved positive, particularly in terms of health.

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Received: 30. September 2013
Accepted: 11. November 2013