CHANGES IN THE INCIDENCE OF SHORTENED MUSCLES IN 11 - 15 –YEAR-OLD GIRLS

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ABSTRACT

The work brings forward the results of our pedagogical research, the aim of which was to obtain and widen the knowledge on developmental changes in the incidence of shortened muscles of 11 to 15-year-old girls and possibilities of their remedy using compensation exercises during physical education and sport lessons. The objects of our observation were 15 girls of an elementary school in Nitra, who were subject to our observation in the consecutive 6th, 7th, 8th and 9th forms. Totally 5 measurements of muscular imbalance and gait were realized. Between measurements No. 2 and 3 an experimental factor was implemented during the period of 4 months. The experimental programme focused on three most frequently shortened muscles and the following muscle groups: knee flexors, musculus rectus femoris and m. quadratus lumborum. Shortened muscles were examined using the method by Janda (1982), which was modified for the purpose of physical education practice by Thurzová (1992). At the first measurement high incidence of shortened muscles was found in all tested pupils. One year after, an increase in the incidence of 8 out of 11 observed muscles was recorded. Having passed the exercise programme, girls recorded lower frequency of incidence of nine postural muscles by 4 – 30%. Results of the experiment showed positive effect of application of aimed exercises within the compulsory P.E. lessons, which was significantly reflected in the status of the postural muscles. When we omitted the compensation exercises after the termination of the experiment, a significant increase in the incidence of shortened muscles was recorded. By an early and adequate impact of aimed exercises within the P.E. lessons it is possible to affect the incidence of shortened muscles in 11 - 15-year-old girls.

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Keywords: muscular malfunctions, shortened muscles, qualitative levels

INTRODUCTION

Functional state of the motor system has been the focus of attention of medical as well as pedagogical public for several decades. The reason is the high incidence of malfunctions of the motor system in adult population. Most frequent disorders are the ones of muscular imbalance, wrong body posture and vertebrogenous disorders (Kanásová, 2005).

In this context, the knowledge on muscular imbalance is very important, because muscular imbalance can be considered the most important malfunction negatively influencing body posture, motor stereotypes, muscular coordination, thus limiting the range of movements in joints, which are unevenly and inadequately loaded (Malátová and Dřevikovská, 2009). Consequences of these processes deteriorate in a substantial way the quality of life of an individual (Bursová *et al* 2001).

It is obvious that between the two muscular systems – the postural and the phasic ones, of which one starts to gain predominance at increased stress and shortening, balance can be disrupted. In such event static-dynamic relationship in the movement system is disrupted. Joints are negatively influenced by shortened muscles, especially in boys, joint flexibility is limited and optimum loading in joints is being changed (Bendíková and Stacho, 2010).

The disposition of muscles for shortening is not clear and we can only state that the motor system, particularly its nervous-muscular system, reacts to improper functional loading as if according to an approved receipt, in a rather stereotyped way, obviously based on the genetically predetermined and in nervous centres coded, scheme of defense (Janda, 1982; Vařeková and Vařeka, 2001; Čermák *et al* 2008).

According to Thurzová (1992) and Kolár (2009) muscular shortening represents the status, when shortening at rest occurs based on various reasons. Shortened muscle is functionally less valuable, since after the intensive contraction it loses the ability to fully relax/stretch into the original length. At more pronounced shortening of the muscle it loses its elasticity, and after a certain period also its strength.

From this point of view, the importance of adequacy of selection of suitable compensatory means focusing on the most frequently shortened muscles in children seems to be rather high. Attractivity of exercises, and mainly their positive impact on health, should form the core of P.E. lessons at school.

The work is aimed at obtaining and enlarging the knowledge on developmental changes of functional disorders of motor system of 11 to 15-year-old girls as well as possibilities of their remedy using compensation exercises within the school physical education and sport lessons.

METHODS

The observed group consisted of 15 girls attending basic school in Nitra, who were persistently studying during 4 consecutive school years (in forms 6, 7, 8 and 9 respectively). All tested pupils formed a single group in the progressive experimental pattern. Shortened muscles were examined using the method by Janda (1982), which was modified for the purpose of physical education practice by Thurzová (1992). The methodology of testing was taken from Kanásová (2005). We observed 11 muscles with the tendency to shorten, where muscles and muscle groups separately on the right and left sides were examined: m. trapezius, pars superior (upper part), m. levator scapulae, m. pectoralis major, m. iliopsoas, m. rectus femoris, m. tensor fasciae latae, lumbal joint adductors, hamstrings, m. quadratus lumborum, m. erector spinae, m. triceps surae. Shortened muscles were evaluated as qualitative signs using two-stage assessment, alloting number 1 to the norm and 2 to shortened muscle.

Based on the number of shortened muscles we deduced the level of the overall shortening of muscles from level I to level IV as follows: Ist level – without muscle shortening, IInd level – light muscle shortening, IIIrd level – middle degree of muscle shortening, IVth level – heavy muscle shortening. Muscular imbalance was evaluated by qualitative symbols.

Experimental factor was implemented in the second year of our experiment, i.e. in 7th form. Experimental factor was formed by a special programme of aimed exercises focusing on the most risky shortened muscles and muscle groups. The group of exercises was elaborated based on the results of observation of the functional state of motor system after two measurements in 6th and 7th forms of elementary school in the observed pupils. We implemented 3 possible variants of stretching exercises according to Lewit (1996) focused on shortened knee flexors, m.quadratus lumborum and m. rectus femoris, which were applied within the compulsory P.E. lessons. We selected exercises, which for the deepening of relaxation of the stretched muscles use the following attenuation; they join the phase of activation of the stretched muscles with inhaling and the phase of their relaxation with exhaling. P.E. and sport was taught within the extent of 2 lessons per week during 4 months with a modified content of education. Experimental pupils did 10 minutes of exercises focusing on the prevention and removal of muscular malfunctions during each lesson.

The following methods were used for the processing and assessment of the obtained data:

a) For indicators of the functional state of the motor system (qualitative analysis of indicators of shortened muscles) percentage and frequency analysis were used.

b) Statistic significance of changes of indicators of shortened muscles as to the distribution of experimental pupils in qualitative zones at individual measurements and statistical significance of differences from the point of view of the sex were evaluated using chi – square (χ^2) method on 1%, 5% and 10% levels of significance. Statistic, subject, practical, but also clinical significance of the statistic test chi square ($\chi 2$) was assessed using the coefficient of effect size – Cramer´s ES "phi" (Effect Size), determining the effect of the experimental result: 0.10 – Minor effect; 0.30 – Medium effect; 0.50 – Major effect (Fan, 2001).

RESULTS

Changes in the incidence of shortened muscles according to qualitative levels

During **the first (input) measurement** at the beginning of form 6, shortened muscles were diagnosed in each child. Therefore, no child was situated in the qualitative grade I, with no muscle shortened. In the qualitative grade II there were 53.3% females and in the grade III - 47% females were classified.

During **the second measurement** realized at the beginning of form 7, when no intervention was implemented, stabilization of the incidence of the observed sign was recorded when compared with the first measurement. Again, no girl belonged to the group I, with no shortened muscles.

Between **measurements 2 and 3** realized after implementing the experimental factor focusing on the removal of the most risky muscles and muscle groups shortening a non significant improvement was recorded. There was an increased percentage (by 27% more than in the previous measurement) of girls with slight shortening of muscles ranking in the qualitative degree II.

At **measurement 4**, no girls ranked among the qualitative group I, while there were 66.7% girls in IInd and 87% girls in the IIIrd qualitative grade. No girls were recorded in the grade IV (Fig. 1), (tab. 1, 2).

Between **measurements 4 and 5** in form 9, a significant ($p < 0.01$) increase in the incidence of shortened muscles in girls was recorded. Girls were markedly shifted from the qualitative group II into III, thus into the zone with higher deviation from the standard (Fig. 1). An infavourable trend – an increase in the number of girls with shortened muscles by almost 50% was recorded in the q.g. III.

Between the **measurements 1 and 5**, after the lapse of three school years, the changes in the distribution of examined girls with the incidence of shortened muscles in qualitative zones were statistically significant ($p<0.05$), where we recorded the increase in the qualitatively more severe zones – with larger deviation from the standard.

Table 1 Changes in the incidence of shortened muscles according to qualitative levels

Grade (%)	Ist grade	IInd grade	IIIrd grade	IVth grade
1. measurement	0.0	53.3	46.7	0.0
2. measurement	0.0	53.3	46.7	0.0
3. measurement	0.0	80.0	20.0	0.0
4. measurement	0.0	66.7	33.3	0.0
5. measurement	0.0	13.3	86.7	0.0

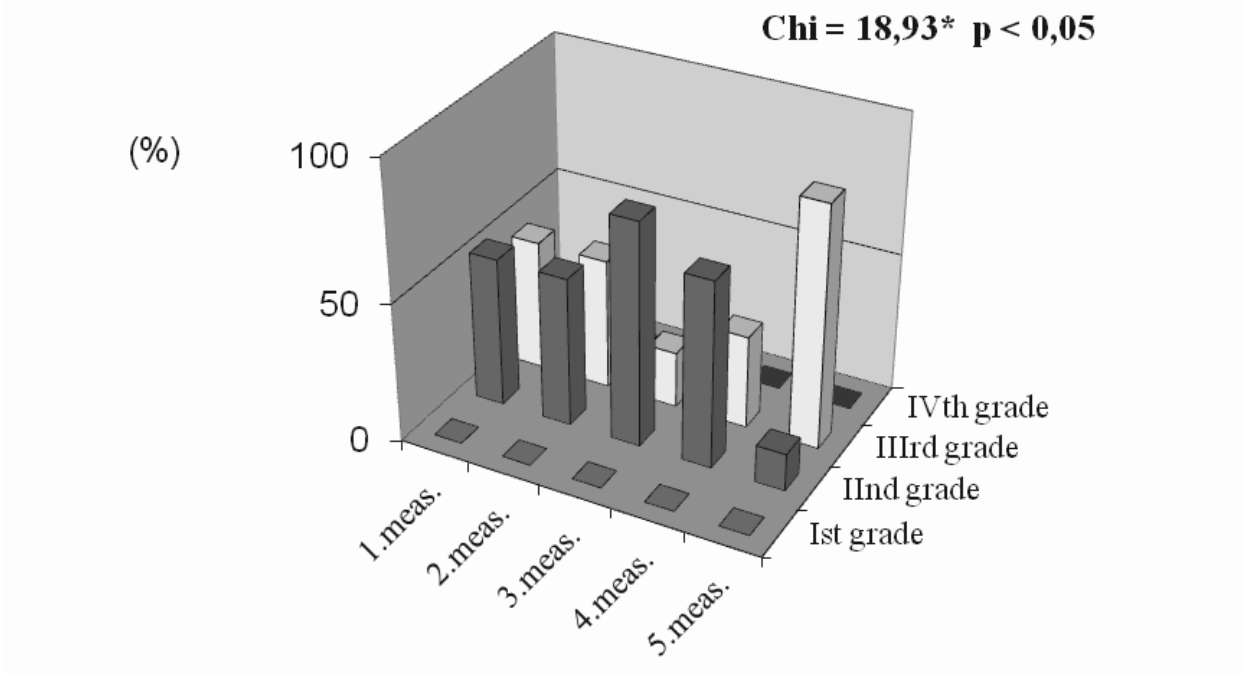


Figure 1
Changes in the incidence of shortened muscles according to qualitative levels - girls

Table 2 Statistic and factual practical significance of changes in the incidence of shortened muscles in girls according to qualitative degrees

Measurement	1.-2.meas.	2.-3. meas.	3.-4. meas.	4.-5. meas.	1.-5. meas.
Chi-Square	0,000	2,400	1,651	9,867**	5,400*
Effect Size	0,00	0,28MiE	0,23MiE	0,57MaE	0,42ME
Explanatory notes:					
Level of significance:: p<0,10(*) p<0,05* p<0,01**		Minor effect MiE, Medium effect ME, Major effect MaE			

Frequency of incidence of shortened muscles

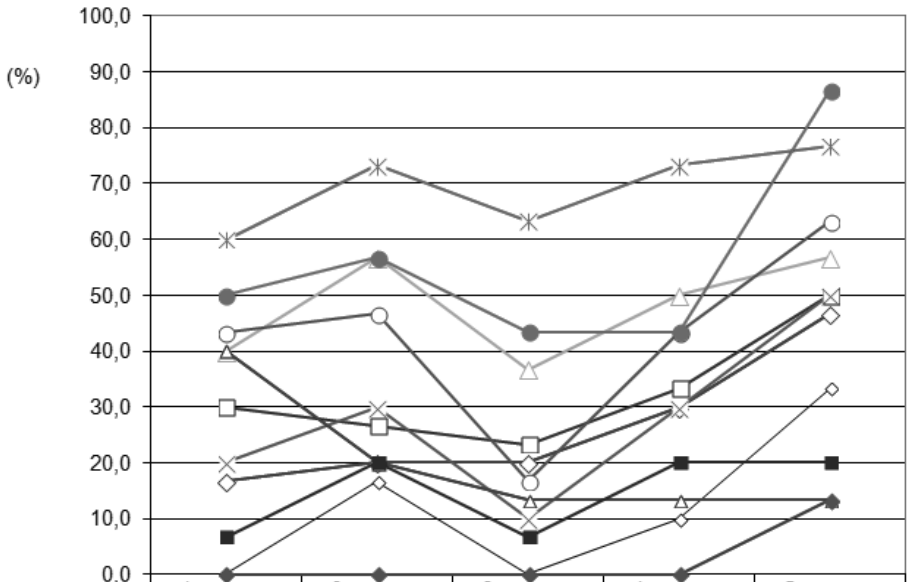
Upon the **first examination** realized at the beginning of form 6 we found that the most frequently shortened muscle in girls was ***m. rectus femoris*** (Fig. 2). At the beginning of the experiment the highest, almost 60% incidence of shortened muscle ***m. rectus femoris*** was found. During the first measurement 50% girls showed shortened ***m. quadratus lumborum,*** ranking second, ***m. tensor fasciae latae*** in 43% gilrs ranking third. Shortened muscles of ***knee flexors*** and ***m. pectoralis major*** in 40% girls ranked fourth.

Upon the **second measurement**, worsening was recorded in 8 of the examined muscles, with the tendency towards shortening. **M. rectus femoris** (73.3%) ranked first, followed by **m. quadratus lumborum** and **m. pectoralis major** (57%), **m. tensor fasciae latae** (47%) and **knee flexors** (20%).

At **examination 3** a marked decrease in the incidence of shortened muscles in all observed muscles was recorded. The order of the first three shortened muscles was identical with the second measurement. **M. rectus femoris** (63%) ranked first, followed by **m. quadratus lumborum** (43,3%) and **m. pectoralis major** (37%) (Fig. 2), which represents the incidence lower almost by one third than the one in the previous measurement. The most marked reduction in the frequency of incidence was recorded at the shortened **m. tensor fasciae latae** - by 30%. Based on the results obtained we can state that reduction of the incidence of individual shortened muscles could be caused by the impact of the focused exercises.

At **measurement 4**, realized 8 months after the termination of impact of the focused programme of exercises we found out that in 8 out of 11 observed muscles and muscle groups the percentage of incidence increased, while in 3 it remained unchanged when compared with **measurement 3**. The first ranked **m. rectus femoris** (73,3%), the second ranked **m. pectoralis major** (50%) and the third ranked **m. quadratus lumborum** and **m. tensor fasciae latae** (43%).

5th measurement was carried out in form 9. An increased incidence of 9 out of 11 observed postural muscles was recorded. No changes were recorded in comparison with the previous measurement. No. one ranked **m. quadratus lumborum** (87%), the second ranked **m. rectus femoris** (77%),the third ranked **m. tensor fasciae latae** (63%) and the fourth ranked **m. pectoralis major** (57%). The highest increase was found in the shortened muscle - **m. quadratus lumborum** (by 42%), **m. tensor fasciae latae** along with **m. iliopsoas** (by 20%). Our results point to the fact that it is inevitable to pay attention to the prevention of muscular imbalance during P.E. lessons at school.



	1.measurement	2.measurement	3.measurement	4.measurement	5.measurement
M.trapezius upper pars	16,7	20,0	20,0	30,0	46,7
M.levator scapulae	30,0	26,7	23,3	33,3	50,0
M.pectoralis major	40,0	56,7	36,7	50,0	56,7
M.iliopsoas	20,0	30,0	10,0	30,0	50,0
M.rectus femoris	60,0	73,3	63,3	73,3	76,7
M.tensor fasciae latae	43,3	46,7	16,7	43,3	63,3
Adductors of hip joint	0,0	16,7	0,0	10,0	33,3
Knee flexors	40,0	20,0	13,3	13,3	13,3
M.quadratus lumborum	50,0	56,7	43,3	43,3	86,7
M.erector spinae	0,0	0,0	0,0	0,0	13,3
M.ticeps surae	6,7	20,0	6,7	20,0	20,0

Figure 2
Occurrence frequency of short muscles - girls

DISCUSSION

Our results proved the current knowledge of numerous authors on **musculus iliopsoas** being the most frequently shortened muscles,in young population, especially in females (Janda, 1982; Máčková *et al*. 1987; Thurzová, 1998; Vařeková and Vařeka, 2001; Dlhoš, 2005; Vobr,2007; Kanásová, 2008; Medeková and Majerík, 2009).

Shortened muscles in the area of flexors (m. rectus femoris, m. tensor fasciae latae, m. iliopsoas) cause muscular imbalance in the area of the pelvis. Shortened m. rectus femoris was recorded in all measurements at rank 1 (with the exception of examination No.5, when it ranked second). The current knowledge on the dominance of m. rectus femoris in the iliopsoas flexors group was thus proved.

It is a compensation mechanism for the stabilization of lumbar joint. Shortened flexors of the lumbar joint cause dynamic changes – rebuilding of the stepping stereotype, the consecutive overloading of lumbosacral segments of the spine with the potential pathological changes in the area of lumbal spine and the pelvis (Thurzová, 1998).

After finishing the period of performing exercises and the one without it, there came to a significant worsening in the incidence of shortened muscles in the observed boys. Dlhoš (2005) came to similar conclusions. He found that 7 months after the termination of the compensation programme the organism of young tennis players reacted reversibly in the manifestation of muscular and joints dysfunction to the loading without adequate compensation procedures.

Reaching the normal length of postural muscles is a prerequisite for being successful in reaching muscular balance, since according to Janda (1982) the conditions for spontaneous strengthening of weakened muscles by their involvement in the particular motor pattern are thus formed. An identical effect of compensation exercises on muscle shortening is documented in the works by Vařeková and Vařeka, 2001; Dlhoš, 2005; Kania – Gudzio and Wiernicka, 2002; Vobr, 2007; Kanásová, 2008).

CONCLUSION

By examining the group of fifteen 11 to 15-year-old girls we diagnosed developmental changes of motor system malfunctions in the sense of shortened muscles. High incidence of shortened muscles started from the first measurement was proved using a single-group continuous experiment.

Shortened muscles played a dominant role in the progression of muscular imbalance in observed girls, since in 6th form, when the functional state of motor system was not influenced by the programme of aimed exercises, only by exercises carried out during P.E. lessons, the incidence of shortened muscles has been stabilized).

After the aimed influence by the focused exercises during P.E. lessons the frequency of incidence of 9 shortened muscles and muscle groups decreased by 4 – 30%, while it did not change in two tested muscles. In children the most pronounced frequency of incidence of shortened muscle - **m. tensor fasciae latae** by 30% was recorded, which showed statistical significance.

When compensation exercises were omitted in the programme of compulsory P.E. lessons in 8th and 9th forms, the significant worsening of the incidence of shortened muscles was recorded. Besides the subject and correlation analyses of chi square ($\chi 2$), Cramer´s ES “phi” was used, which assessed the found results as medium large effect size. The conclusion is that the results were not influenced by the statistical means.

Based on the results of the experiment we can deservedly recommend for the physical education practice aimed and long-term exploitation of exercises for the compensation of static loading of motor system within the school physical education and sport lessons and prevention of functional disorders of the motor system.

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