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The Impact of Compensation Exercises on the Muscle Imbalance at 15-Year-Old Students

Prace Naukowe Akademii im. Jana Długosza w Częstochowie. Kultura Fizyczna 13/1, 151-159

2014

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Kultura Fizyczna 2014, t. XIII, nr 1

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Abstract

The aim of this work was to gain and broaden the knowledge about muscle imbalance in first year high school students and to determine the impact of compensational program on the changes in muscle imbalance. The file was comprised of 49 students from two classes aged 15 to 16 years. The classes were randomly divided into an experimental (n=25) and control (n=24) file and became a subject of a double-group concurrently ongoing experiment. We examined the students with functional tests to identify tightened and weakened muscles and abnormal motion patterns. The examination included tests of motion capabilities as well. By means of input measurements we have observed a high frequency of muscle imbalance in the entire file of students. An experimental element – the compensational exercises were incorporated into the physical education classes of the experimental file for a time period of 9 months. The compensation exercises consisted mainly of stretching exercises, exercises aimed at the activation and strengthening of the core muscles, stabilizing exercises and functional exercises. The experimental element also included theoretical blocks. We have not observed statistic changes in the individual parts of muscle imbalance in the output measurements of the control file. Statistically significant changes ($p<0,01$), ($p<0,05$) occurred in the experimental file in a majority of cases and compensation exercises had a great impact on the decreasing of incidence of the individual disorders.

Keywords: muscle imbalance, compensation exercises, school physical education, possibilities of influencing muscle imbalance, functional disorders, motion apparatus

Introduction

The theme of insufficient movement activity and its potential negative impact, which is unfortunately very common nowadays, has been frequently discussed in both scientific and unscientific spheres over the course of the recent years. One of the mentioned negative impacts is the muscle imbalance. Muscle

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imbalance and functional dysfunctions of the movement apparatus are along with obesity a frequent problem occurring even to the youngest students. These troubles often continue during the entire study and until adultness. In the worst scenario, such disorders may turn into a significant health handicap in the maturity or even at an earlier age. Thurzová [22] defines the muscle imbalance as a disorder in the function of muscle balance and as a disorder in the equality of force which is applied to a relevant joint. It is an imbalance in the system of tonic (postural) and fazic muscles. We consider it the most relevant cause of the chronic pain of the movement apparatus and of spinal disorders. It negatively affects the body posture, muscle coordination, increases predisposition for injuries and restricts the range of movement in the joints [2].

The causes of muscle imbalance according to Lewit [17]:

1. hypo kinesis – insufficient burdening of the muscle system
2. chronic burdening above the border given by the quality of muscle
3. asymmetric burdening without sufficient compensation
4. the change of a movement pattern e.g. under the influence of an injury or illness

Investigation dedicated to the muscle imbalance is a subject of works of a number of authors [3, 4, 5, 7, 8, 12, 13, 14, 16, 17, 20, 21, 22 i.e.] both from Slovakia and abroad. The results of these works were approximately matching – they proved a large incidence of muscle imbalance in all age categories of population actively sporting as well as at the rest of it. Our research was dedicated to the inquiry of the impact of compensation exercises on the improvement of muscle imbalance. The compensation exercises were applied to students during the physical education classes.

Aim

The objective and purpose of this study is to broaden the knowledge about muscle imbalance and about the possibilities of its improvement by the compensation exercises applied to 15-year-old students during the physical education classes.

Research question

What will be the impact of the physical education classes modified by the compensation exercises on the changes of the muscle imbalance?

Methods

The experimental element was composed of compensation exercises which were included into the content of physical education classes of the experimental file of students. The compensation exercises themselves were performed generally in the beginning and at the end of each physical education class – 2 times a week. Except for the physical education classes the compensation exercises were applied during a block of 5 classes in each semester, which were created for the purpose of our research. These classes were dedicated solely to the compensation exercises. The complexity of exercises was gradually increased according to the accomplished progress. In the beginning, exercises using just the own body weight were applied only in the elementary positions. After achieving progress in the basic – elementary positions we have added a number of traditional exercise equipment according to the nature of each kind of exercise. The exercise utensils included long-established instruments such as medicine ball, gymnastics instruments i.e. as well as more modern ones such as: TRX, fit balls, over balls, expanders, and balance instruments, bosu, i.e. which contributed to the attractiveness of exercise.

The exercises were aimed at:

— stretching – static, dynamic, PNF and PIR
— relaxing exercises, relaxing techniques, breathing exercises
— strengthening exercises – functional training, stabilizing, balancing, gymnastic, exercises, exercises focused on the body center "core"

The inquiry of muscle imbalance was performed by the method which can be found mainly in the works of a number of authors [9, 15, 18]. We have tested the length of 9 muscles with the tendency to tighten and 5 muscles resp. groups of muscles with the tendency to grow weaker. Further, we have inquired the quality of 5 movement patterns.

The differences and changes in the muscle imbalance were compared by means of the chi – square statistic. The subject matter and practical significance was estimated via Effect size. We used the significance level $p < 0,05$ to $p < 0,10$. Data were processed in Microsoft Excel.

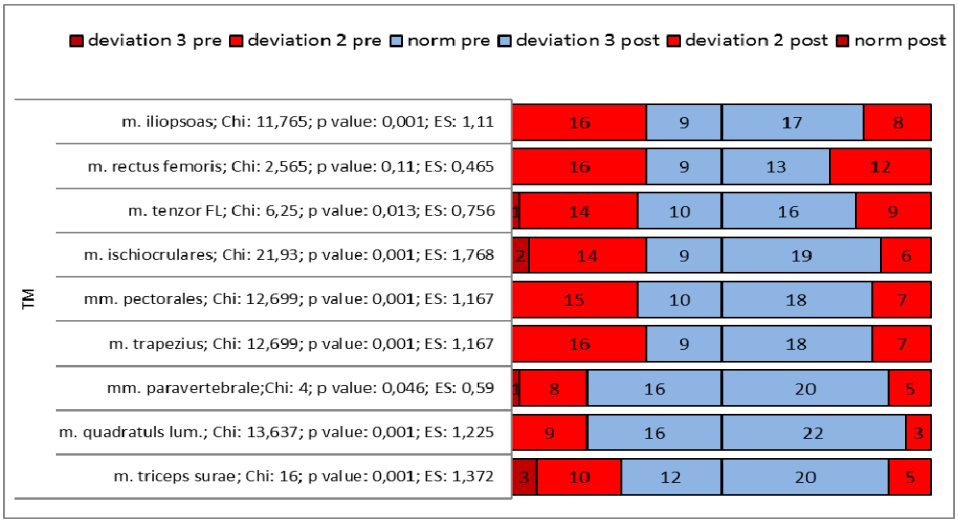
Results

The results of our research confirmed a high incidence of muscle imbalance among the age category of tested students, i.e. 15 years old. We have detected muscle imbalance in 94% of the tested file of students. A high incidence was detected in all branches of muscle imbalance which we have inquired (tightened muscles, weakened muscles, broken movement patterns).

The output measurement has shown that our experimental element – compensation exercises – have considerably influenced the individual branches of muscle imbalance. We have succeeded in reducing the incidence of muscle imbalance from 100% to 88% in the experimental group.

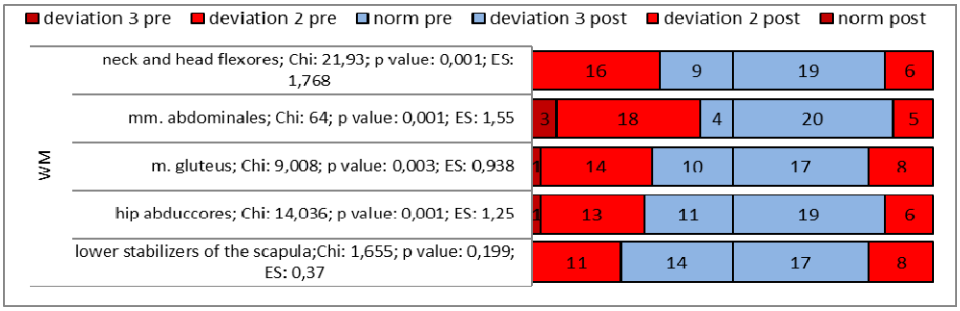
Concerning the tightened muscles (Picture 1) we have detected a decrease of muscle imbalance among all the inquired muscles. The changes weren't statistically significant only in m. rectus femoris on the right side. The changes were detected on the level of ($p<0,01$) and ($p<0,05$) of the statistical significance. The results were confirmed by the high value of "Effect size" (ES). The positive effect of the experiment was highlighted by the fact that during output measurement we have not detected any muscle with considerable tightness. The most frequently tightened muscle at the beginning of the experiment was the m. iliopsoas, however at the end of the experiment it was the m. rectus femoris.

The results of our research as well as the findings of other authors confirm the positive effect of compensation exercises on tightened muscles. Stretching exercises have a direct – positive impact on the tightened muscles, however they must be aimed at concrete muscle groups and they must be performed with the use of an appropriate technique and with sufficient frequency.



Picture 1. The ratio of incidence of tightened muscles on the left side – experimental group input (pre) and output (post) measurement

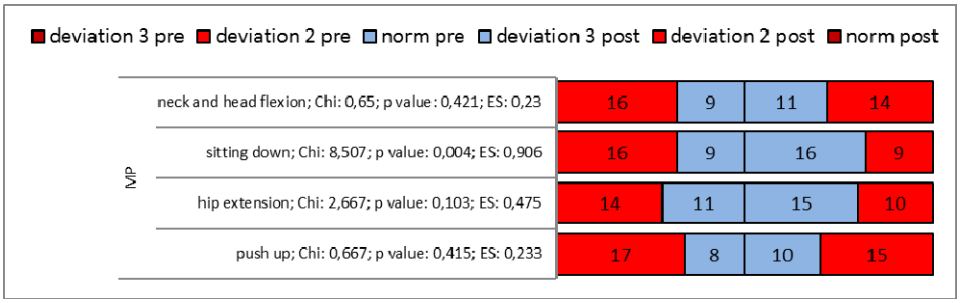
We have detected a decrease of muscle imbalance when testing all tightened muscles (picture 2). We have not detected a statistically significant change only in the inquiry of the lower stabilizers of scapula. The notably positive effect of our program was confirmed by a high value of the Effect Size. In all cases, the change was confirmed on 1% level of statistical significance ($p<0,01$).



Picture 2. The ratio of incidence of weakened muscles on the right side – experimental group input (pre) and output (post) measurement

During the investigation of weakened muscles in the output measurement we have not detected a muscle which would be marked by degree "3", which in the terminology of weakened muscles means major weakness. The slightest improvement was recognized in testing the lower stabilizers of scapula; however the greatest improvement – strengthening was detected at the abdominal muscles. We have paid an advanced attention to the abdominal muscles in consent with the entire "core" complex of our program.

Positive changes in the incidence of disturbed muscle patterns were detected in testing each pattern (picture 3). Statistically significant changes were confirmed in the pattern of sitting down ($p<0,01$) and at the extension of the lumbar joint ($p<0,05$).

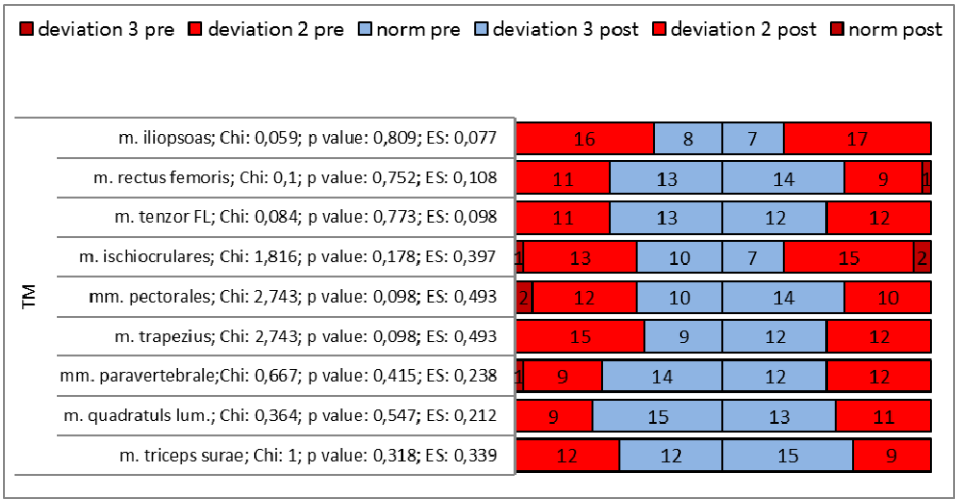


Picture 3. The ratio of incidence of disturbed patterns on the right side – experimental files input (pre) and output (post) measurement.

From the point of view of correction of the functional defects, the restitution of a disturbed movement pattern is considered the most complicated and at the same time the most important one. Over all we can state that the aimed integration of compensation program into the physical education classes have reduced the incidence of this defect in the experimental file, however a statistically significant change was not detected in all movement patterns. The most noticeably improved pattern was the pattern of sitting down. This fact is probably related to

the abdominal muscles which we have succeeded in strengthening at the majority of students. We have also accomplished to engage the abdominal muscles into the movement patterns of students in a correct movement pattern.

In the control file, where the experimental element was not present, we have not detected any improvement in the incidence of muscle imbalance. In testing the tightened muscles (picture 4) we have even noticed an increase of occurrence of this defect. In testing of the weakened and disturbed patterns we have observed a slight improvement, which however was not statistically significant.



Picture 4. The ratio of incidence of tightened muscles on the left side – the control files input (pre) and output (post) measurement

Conclusions

The integration of compensation exercises into the physical education classes had a significant impact on the incidence of muscle imbalance in the experimental file in comparison to the input measurement as well as in comparison to the control file. The muscle imbalance is according to a number of authors a defect which often results into serious health complications and limitations. The search for the possibilities of prevention of the muscle imbalance and the prevention of all functional defects of the movement apparatus is nowadays becoming more and more up to date.

On the bassis of the works of other authors as well as of the results of our research we can state that the integration of compensation exercises into the classes of physical education is helpful in reducing the incidence of individual defects related to the muscle imbalance. However, an effective compensation pro-

gram demands an active cooperation between the teacher and the student, without such cooperation no positive results can be achieved.

For the compensation program to be effective, it must be performed by a pedagogue who is well – educated in the relevant field. Another important condition of success is the motivation of students. In our program we have proved the effectiveness of theoretical blocks in the form of presentations, which were dedicated to the risks related to the functional defects of the movement apparatus, unhealthy life style and to the theory of compensation exercises. Another motivation element was the variety of used equipment and tools. Compensation exercises may often be boring and monotonous and therefore it may be difficult to focus the attention of students – mainly the younger ones. However, attention is the key factor in performing all compensation exercises. The diversity and attractiveness of compensation exercises in our program was secured by the use of various tools and utensils and by using different stretching and strengthening techniques and exercises which we have previously presented to the students during the theoretical blocks.

We recommend solving the problem of muscle imbalance complexly due to the fact that the muscular system always works as a functional unit. This mechanism works through individual muscle chains and loops and it is frequently the main reason for a defect to have a number of "triggers". It is also common that the reason for a defect is located in a completely different body segment than its effects are displayed in. The exercises aimed at the activation and strengthening of the body core in combination with the philosophy of the functional training have proved to be effective and we consider them to be the compulsory component of the compensation exercises. We recommend integrating the compensation exercises into the classes of physical education of all age groups of students instead of exercises which are aimed at isolated muscle groups and work solely with the surface muscles.

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Streszczenie

Wpływ ćwiczeń kompensacyjnych na brak równowagi mięśniowej u 15-latków

Celem pracy było zdobycie i poszerzenie wiedzy na temat nierównowagi mięśniowej u uczniów pierwszej klasy szkoły średniej oraz określenie wpływu, jaki wywiera program kompensacyjny na zmiany nierównowagi mięśniowej. Badana grupa składała się z 49 uczniów z dwóch klas w wieku od 15 do 16 roku życia. Klasy podzielono losowo na doświadczalną grupę (n = 25) i kontrolną grupę (n = 24), które stały się przedmiotem badań w jednocześnie trwającym eksperymencie. Uczniów poddano próbie testów funkcjonalnych w celu zidentyfikowania skróconych i osłabionych mięśni oraz patologicznych stereotypów ruchowych. Badania zawierały testy dotyczące możliwości ruchu, a za pomocą pomiarów wejściowych zaobserwowaliśmy wysoką częstotliwość nierównowagi mięśni w całej grupie uczniów. Komponent eksperymentalny – ćwiczenia kompensacyjne wprowadzono do zajęć wychowania fizycznego w badanej grupie na okres 9 miesięcy. Ćwiczenia kompensacyjne – składały się głównie z ćwiczeń rozciągających, mających na celu aktywizację i wzmocnienie mięśni tułowia, ćwiczenia stabilizujące i ćwiczenia funkcjonalne. Komponent eksperymentalny obejmował również bloki teoretyczne. Nie zaobserwowano zmian statystycznych w poszczególnych grupach kontrolnych dotyczących braku równowagi mięśniowej. Statystycznie znaczące zmiany ($p < 0,01$) ($p < 0,05$) występowały w większości przypadków i ćwiczenia kompensacyjne miały większy wpływ na zmniejszenie częstości występowania poszczególnych zaburzeń.

Słowa kluczowe: zaburzenia równowagi mięśniowej, ćwiczenia kompensacyjne, szkoła wychowania fizycznego, możliwości wpływania na równowagę mięśniową, zaburzenia czynnościowe, aparaty ruchu.