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# EFFECTS OF TWO DIFFERENT TRAINING PROGRAMS ON THE SIT-UP TEST IN THE SEVENTH GRADE ELEMENTARY SCHOOL STUDENTS

## UTJECAJ DVA RAZLIČITA TRENAŽNA PROGRAMA NA TEST PODIZANJE TRUPA IZ LEŽANJA U SJED KOD UČENIKA SEDMIH RAZREDA OSNOVNE ŠKOLE

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**SUMMARY**

Sit-up tests are used for measuring muscular endurance at physical education class. The aim of the study was to compare the efficiency of two types of the training process: core stabilization exercises and traditional trunk exercises on the sit-up test performed by the seventh grade elementary students. Sixty students began with the participation in the experimental program, and forty seven of them (age 13,7 ± 0,3 years, height 161.6 cm ± 7.01 cm, weight 52.55 kg ± 11.73 kg) completed the program. The classes were randomly divided into a control group which worked on a running technique (RTE) (N=14), an experimental group which performed traditional trunk exercises (TTE, N=16) and another experimental group which performed core stabilization exercizes (CSE, N=17). The training process lasted for six weeks. During that period physical education classes were held ten times. The initial measurement was done a week before the beginning of the treatment, and the final measurement a week after finishing the treatment. The average difference between the results in the initial and final measurement was greatest with the students who performed the additional training of core stabilization exercises (d=4.53), somewhat smaller with those who performed the additional training of traditional trunk exercises (d=3.56), and the smallest with students in the control group (d=0.29). In both experimental groups the difference between the mean in the initial and final state was statistically significant, while at students in the control group the aforementioned difference did not reach the level of statistical significance. Core stabilization exercises and traditional trunk exercises efficiently improve the muscular endurance of the trunk muscles. Trunk muscle strengthening is better recommended with core stabilization exercises, since they enable an efficient improvement of the muscular endurance without long-term detrimental effects on the spine.

*Key words:* sit-up, core, low back pain, physical education, muscular endurance.

**SAŽETAK**

Na nastavi TZK jedan od testova za provjeravanje motoričkih sposobnosti je podizanje trupa iz ležanja u sjed. Navedenim testom se provjerava repetitivna jakost trupa učenika.

Cilj je bio usporediti efikasnost dviju vrsta treninga: stabilizacijskih vježbi i pregiba trupa na test podizanje trupa iz ležanja u sjed kod učenika sedmih razreda osnovne škole. Uzorak ispitanika sačinjavalo je 47 učenika sedmih razreda osnovne škole. Razredi su slučajnim odabirom podijeljeni na kontrolnu skupinu, koji su radili na tehnici trčanja (n=14), eksperimentalnu skupinu koja je provodila pregibe trupa (TRB, n=16) i eksperimentalnu skupinu koja je provodila stabilizacijske vježbe (STAB, n=17).

Trenažni proces se odvijao u periodu od 6 tjedana. U tom periodu je provedeno 10 sati nastave TZK-a. Mjerenje je izvršeno na početku i nakon 6 tjedana trenažnog procesa. Prosječna razlika između rezultata u inicijalnom i finalnom mjerenju bila je najveća kod učenika koji su provodili dopunski trening stabilizacijskih vježbi (d=4,53), nešto manja kod kojima su sadržaj dopunskog treninga bile vježbe pregiba trupa (d=3,56), a najmanja kod učenika u kontrolnoj grupi (0,29). Kod obje eksperimentalne skupine razlika između aritmetičke sredine u inicijalnom i finalnom stanju bila je statistički značajna, dok kod učenika kontrolne skupine navedena razlika nije dosegla razinu statističke značajnosti. Stabilizacijske vježbe i pregibi trupa efikasno razvijaju repetitivnu jakost mišića prednje i bočne strane trupa. Jakost mišića trupa bilo bi preporučljivo razvijati stabilizacijskim vježbama, jer omogućuju efikasno poboljšanje jakosti mišića trupa bez dugoročno štetnih posljedica na kralježnicu.

*Ključne riječi:* podizanje trupa, core, lumbalni bolni sindrom, tjelesna i zdravstvena kultura, repetitivna jakost.

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## INTRODUCTION

Sit-ups is a widely spread exercise used for improving abdominal and hip flexor muscular endurance. Despite the exercise being popular and wide spread, during performance it causes increased pressure on the spine, potentially increasing the risk of back injuries and back pain. Sit-ups causes a strong pressure on intervertebral discs dominantly along the lumbar spine (3, 18, 21). An increased activity of the abdominal muscles during the sit-ups causes an initial hyperextension and consequently a hyperflexion of the lumbar spine, creating strong compressive forces in the lumbar part of the spine (22, 24), the values of which can reach up to 3 350 N (19). In order to avoid unnecessary risk, health and fitness experts recommend performing core stabilization exercises to strengthten the abdominal musculature (1). The recommendations are based on the evidence that these exercises strengthen the trunk muscles (m.transversus abdominis, m.multifidi, m.erector spinae, m.quadratus lumborum etc.) included in controlling the forces along the lumbar part of the spine (9, 10, 11, 12, 13). The studies have proven that these exercises increase trunk muscle activity in controlled conditions, which include low pressure on the spine with minimal movements, contributing in that way to the functionality of the spine and to a better neuromuscular trunk control (17, 20, 21, 22, 23, 24, 25). During stabilization exercises, the muscle contraction has a great effect on the abdominal musculature, while at the same time it minimizes potential detrimental effects of the forces along the lumbar spine (3, 4, 7, 8). One of the tests for controlling motoric abilities at the physical education (PE) class is the sit-up. The primary goal of this study was to compare the efficiency of two types of the training process: core stabilization exercises and traditional trunk exercises on the sit-up test performed by seventh grade elementary students.

## METHODS

### *PARTICIPANTS*

The sample of respondents included three seventh grades of elementary school. Sixty students began with the participation in the experimental program, and forty seven of them (age 13,7 ± 0,3 years, height 161.6 cm ± 7.01 cm, weight 52.55 kg ± 11.73 kg) completed the program. The students who were absent for three or more times from the Physical Education class were excluded from the study. The classes were randomly divided into a control group which worked on a running technique (RTE) (n=14), an experimental group which performed traditional trunk exercises (TTE, N=16) and another experimental group which performed core stabilization exercises (CSE, N=17).

### *VARIABLES*

The sit-up test in the initial and final measurement was used as a variable sample. The initial measurement was done a week before the beginning of the treatment, and the final measurement a week after finishing the treatment.

### *EXPERIMENTAL TREATMENT*

The training process lasted for six weeks (Table 1). During that period PE classes were held ten times, two less than proscribed by the curriculum and the program, due to an excursion and a state holiday. At the beginning of each class the students did a dynamic warm-up, followed by a strength training. Both experimental groups (TTE and CSE) performed exercises in pairs (Figures 1-6). Within each pair, while ones performed exercises, others corrected and motivated their partner. After the strength exercises the students continued with their regular curriculum and program. Strength exercises were performed in the order shown in Table 1.

Table 1 - Exercise performance order
Tablica 1- Redoslijed izvođenja vježbi

| Period | Week 1-2 | | Week 3-4 | | Week 5-6 | |
|---|---|---|---|---|---|---|
| CSE group exercises | SAPL-AEP | PL | SAPL-AEP | PL | SAPL-AEP | SPL |
| TTE group exercises | SIT | RCNTR | RCNTR | SIT | RCTR | SIT |
| Number of series | 3 | 2 | 3 | 2 | 3 | 2 |
| Exercise intensity | moderate | | moderate | | moderate | |
| Exercise duration | 20 seconds | | 25 seconds | | 30 seconds | |
| Pause between series | 25 seconds | | 30 seconds | | 35 seconds | |

Core stabilization exercises (CSE) group:

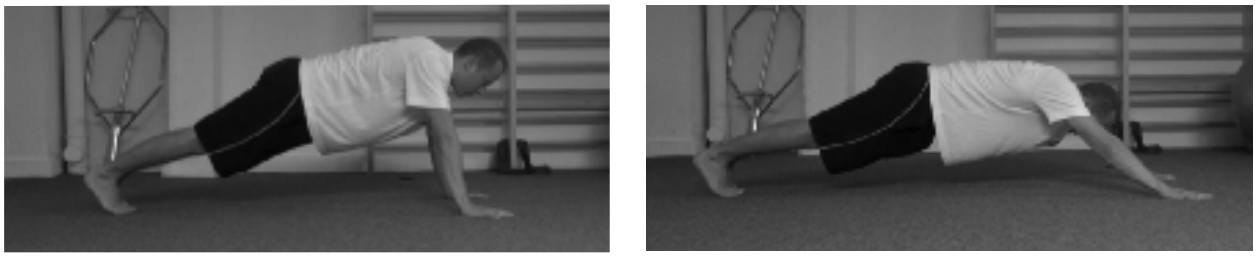


Figure1. Straight arm plank up to arm extension plank (SAPL-AEP)
Slika 1. Slika 1.: Upor na podlakticama (UP)

Figure 2. Plank (PL)
Slika2. Slika2.: Upor na podlakticama - „spiderman“ (UP-S)

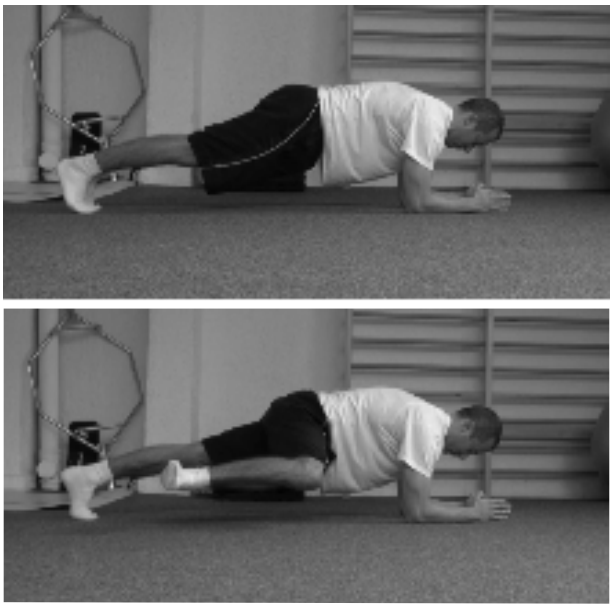


Figure 3. Spiderman plank (SPL)
Slika 3. Slika 3.: Upor na rukama do upora uzručenjem (UR-UZ)

Traditional trunk exercises (TTE) group:

Figure 4. Sit-up (SIT)
Slika 4. Slika 4: Podizanje trupa -dlanovi na potiljku (PTP)

Figure 5. Raised leg crunch, no trunk rotation (RCNTR)
Slika 5.Slika 5.:Podizanje trupa (dlanovi na potiljku) bez rotacije, noge u zraku (PTNZ)

Figure 6. Raised leg crunch, with trunk rotation (RCTR)
Slika 6. Slika 6.: Podizanje trupa (dlanovi na potiljku) s rotacijom, noge u zraku (PTRNZ)

## DATA ANALYSIS METHODS

The data have been processed with STATISTICA program, version 8.0 (StatSoft,Inc., Tulsa, OK, USA). The students' results from the sit-up test are presented with a mean and a standard deviation. The differences between the means of the results in the aforementioned test in the initial and final measurement are tested with t-test for dependent samples. The differences in the progress of the students in the control group and those in the experimental groups in the muscular endurance are tested with a two-way analysis variance in repeated measures. In doing so, the categorical predictors were group (two experimental and one control group) and measurement (initial and final measurement), and dependent variable the sit-up. The borderline p-value is set on $p<0.05$ in all analyses.

## RESULTS

The effects of a six-week additional training on muscular endurance in seventh grade students are demonstrated in Table 2.

Table 2. The effects of a six-week additional training on muscular endurance in seventh grade elementary school students

Tablica 2. Učinci 6-tjednog dopunskog treninga na repetitivnu jakost trupa učenika 7. razreda

| Group | MPT* ($\chi \pm s$)† | | |
|---|---|---|---|
| | Initial measurement | Final measurement | p‡ |
| Experimental- TTE | 41.94 ± 5.64 | 45.50 ± 4,68 | 0.001 |
| Experimental- CSE | 39.88 ± 6.85 | 44.41 ± 7,79 | < 0.001 |
| Control - RTE | 42.07 ± 8.29 | 42.36 ± 8,29 | 0.762 |

* Muscular endurance Test – The sit-up

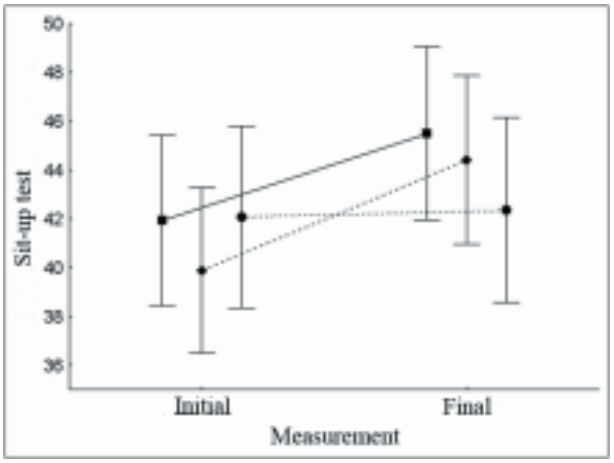
† Mean ± Standard deviation

‡ Statistical significance of the difference between the mean in the initial and final measurement (p-value determined by t-test for dependent samples).

The P-value determined by a two-way analysis variance in repeated measures turned out to be p=0.002, which shows that the groups of participants were significantly different in progress between the initial and final measurement. The average difference between the results in the initial and final measurement was greatest with the students who performed the additional training of core stabilization exercises (d=4.53); somewhat smaller with those who performed the additional training of traditional trunk exercises (d=3.56), and the smallest with students in the control group (d=0.29) (Chart 1).

Chart 1. The Differences in muscular endurance increase between the seventh grade students involved in the six-week additional training and the control group

Graf 1. Razlike u povećanju repetitivne jakosti trupa između učenika 7. razreda uključenih u 6-tjedni dopunski trening i kontrolne skupine




- Eksperimental group – traditional trunk exercises
- Eksperimental group – core stabilization exercises
- Control group – running technique exercises

In both experimental groups the difference between the mean in the initial and final state was statistically significant p=0,01, while at students in the control group the aforementioned difference did not reach the level of statistical significance p=0,762.

## DISCUSSION AND CONCLUSION

The primary goal of this study was to compare the efficiency of two types of training: core stabilization exercises and the traditional trunk exercises performed by seventh grade elementary students. The results of this study have shown that both experimental groups achieved a statistically significant improvement in the sit-up test.

The experimental group which performed core stabilization exercises achieved the greatest improvement between the initial and final measurement (d=4.53), the experimental group which performed traditional trunk exercises achieved a somewhat smaller one (d=3.56), while the control group that worked on a running technique made the smallest progress (0.29). The core stabilization exercise group had in average a somewhat lower initial state (39.88 ± 6.85) compared with the traditional trunk exercises group (41.94 ± 5.64) and possibly that is the reason why it made a greater progress. The results of our study, though conducted on a smaller sample and in a shorter period, have some similarities to the results of the study done in the U.S. Army. One of the fitness tests for the U.S. Army is the sit-up in the period of two minutes. Childs et al. (6) conducted a study researching the influence of core stabilization exercises program and traditional exercise program with the aforementioned test on a sample of 2616 participants. The training process lasted 12 weeks, 4 trainings a day. At the beginning of the treatment there were no significant differences between groups (P=0.543). The soldiers who performed core stabilization exercises program had a 5.6% greater pass on the sit-up test compared with the group which performed traditional exercise program 3.9% (P=0.004). According to our study, but also according to the study conducted in the U.S. Army, we can conclude that core stabilization exercises and traditional trunk exercises efficiently improve the muscular endurance of front and lateral trunk muscles. Although both methods have proven efficient in front and lateral trunk muscles improvement, in performing traditional exercise

program, there are repetitive spine flexions as well. With repetitive flexions the discs are being damaged, and the space between the vertebrae is becoming thinner (26). Every person's intervertebral discs have a determined number of tolerance to flexion before the damage occurs (5). On the other hand, core stabilization exercises program improve front and lateral trunk muscles just as equally with minimal spine movements, contributing to its better functionality. With all these facts taken into consideration, we can conclude that the trunk muscle strengthening is better recommended with core stabilization exercises, since they enable an efficient improvement of the muscular endurance without long-term detrimental effects on the spine.

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