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EFFECTS OF EXERCISE PROGRAMS ON UPPER CROSSED SYNDROME: A SYSTEMATIC REVIEW

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SUMMARY

Keeping the head in a forward position can, in the long run, cause a postural disorder termed upper crossed syndrome – UCS. Upper crossed syndrome is defined as overactivity, or tightening, of the upper trapezius, major pectoralis and levator scapulae, combined with a weakened rhomboid, serratus anterior, middle and lower trapezius, as well as deep cervical flexors. This posture can result in neck pain, as well as upper back pain. The syndrome has been exacerbated with technological advancement, and the ever-increasing use of computers and smartphones. It affects school-age children, university students, as well as employees who work in an incorrect position or repeat the same actions throughout their working day. Physical exercise, namely, strength and stretching exercises, is one of the possible methods of correcting this postural disorder. Therefore, the objective of this study is to conduct a systematic review of studies to date in order to determine the effects of implementing different exercise programs on the treatment of upper crossed syndrome. The analyzed scientific papers were collected by searching online databases of electronic academic journals: Google Scholar, PubMed, Wolters Kluwer. The review focused on papers published between 2000 and 2019. Key words used for searching the databases included: upper crossed syndrome, effects, exercise program. Studies were included based on meeting the following criteria: examining the effects of different exercise programs on upper crossed syndrome, as well as on reducing neck and upper back pain, and improving functional ability. Based on the criteria set, a total of 15 studies were included in the final analysis. The final analysis established that upper crossed syndrome was affected most favorably by programs containing strength and stretching exercises, when these were administered over a 4-week period, with a minimum weekly frequency of 3 practice sessions.

Key words: Upper crossed syndrome, training, strength, flexibility

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INTRODUCTION

Postural disorders and spinal deformities can be congenital or acquired. Acquired postural disorders can be a consequence, to a large extent, of contemporary living and working conditions. Some of the most typical factors include continuous use of mobile phones and computers, working in sedentary jobs, etc. Prolonged incorrect posture and reduced physical activity presents a disbalance in the musculature (Tiefel, 2012). It can also lead to vision issues, as well as headaches, musculo-skeletal issues and pain, as well as a multitude of other symptoms.

Prolonged periods where the head is positioned forward can cause the postural disorder termed “upper crossed syndrome” (UCS; also: proximal or shoulder girdle crossed syndrome), which includes increased cervical lordosis combined with upper thoracic kyphosis (Kang, Choi, Jeong, Choi, Moon, *et al*. 2018; Arshadi, Ghasemi, & Samadi, 2019). A person affected by this syndrome typically presents with a forward head posture, rounded shoulders, and scapular winging.

Such posture need not result in pain necessarily; however, if the condition continues over a longer period, this can result in pain in the upper back, neck, shoulders, as well as shoulder blade area. Headaches are very frequent in this syndrome, which can adversely affect one’s quality of life (Daneshmandi, 2017).

Based on research and clinical observation, Vladimir Janda identified crossed syndromes in 1979. These syndromes represent a muscular imbalance between the upper and lower extremities. Dr Janda termed one of the syndromes Upper Crossed Syndrome, since weak and shortened upper-body muscles overlap, creating muscle imbalance (Magklaras, 2008).

Upper crossed syndrome is defined as the overactivity or straining of the upper trapezius, major pectoralis and levator scapulae, combined with weakness of the rhomboid, serratus anterior, middle and lower trapezius, as well as of deep cervical flexors, in particular the scalene muscles. The above results in a frequent postural pattern of forward shoulders, increased kyphosis, forward head posture (FHP), and the loss of, or reduction in, cervical lordosis. This syndrome also results in shoulder elevation and protraction, inward rotation of the shoulders, as well as winged scapula (scapulae allatae) (Moore, 2004).

There is a relation between the forward head position (FHP) and rounded shoulders, as well as between rounded shoulders and kyphosis (Arshadi, 2019). Forward head position is closely linked with thoracic kyphosis (Singla & Veqar, 2017). The simultaneous presence of FHP and rounded shoulders is part of the postural disorder termed upper crossed syndrome (Mujawar & Sagar, 2019). Deep neck muscles play a major role in correct neck posture. In people who have forward head position, these muscles are weak, elongated, and insufficiently activated (Kang, 2015).

Technological advancement and the ever-increasing use of computers and smartphones over prolonged periods has coincided with a greater incidence and exacerbation of this syndrome (Kong, Kim & Shim, 2017; Kang, *et al*. 2018). Device users tend to bend their neck and head in order to view the screen, and this positioning of the neck and head over longer periods can cause disorders of the muscle-skeletal system, such as upper crossed syndrome (Park, *et al.* 2015). In addition to the above, the school environment also plays an important role when it comes to the development of this syndrome. Students often sit with an incorrect posture where the neck, shoulders and back are fixed over prolonged periods during school lessons, and physical inactivity is yet another risk factor. According to Jorgić, Đorđević, Milenković, & Stanković (2020), 60.4% of students in the eighth grade have a postural disorder. Long-term bad posture while sitting incorrectly can affect the activation of neck muscles, or deep cervical flexors (Park, Kim, Seok, & Lee, 2014). Activities such as physical work during the performance of a job can cause disorders of the musculo-skeletal system. For example, this may apply to workers who maintain incorrect posture while doing their jobs, or those whose working day involves repetition of the same activities (Mujawar & Sagar, 2019). Given the adverse health effects of this syndrome, various types of treatment are available, with a view to treating it and correcting postural status. In view of the above, the objective of this study is to conduct a systematic review of studies conducted to date, and to determine the effects of the application of various exercise programs on treating upper crossed syndrome.

RESEARCH METHODOLOGY

The present study used the descriptive method, that is, the method of observation. The studies analyzed were collected by searching the online databases of the electronic issues of academic journals: Google Scholar, PubMed, Wolters Kluwer. The search was focused on studies published between 2004 and 2019. The key words used for searching the databases included: *upper crossed syndrome, exercise, forward head posture, effects*. The criteria for study inclusion were the following: the study examines the effect of different exercise programs on upper crossed syndrome, on reducing neck and upper back pain, and on enhancing functional ability. Retrieved study titles, abstracts and full texts were then analyzed. The studies which met the criteria stated were analyzed and presented according to the following parameters: reference (leading author's last name and year the study was published, participant sample, age, total number and participant subgroups), physical exercise program, program duration, and study results.

STUDY RESULTS

Image 1 presents the procedure for collecting, analyzing and eliminating the studies retrieved. A search of the academic databases retrieved a large number of studies – 8,000. A majority of these were eliminated based on their abstract, title, the period when they were published, limiting the selection to papers published between 2000 and 2019. Having satisfied the conditions set, a total of 15 papers were included in the final analysis.

Image 1. The process of collecting, analyzing and eliminating the retrieved papers

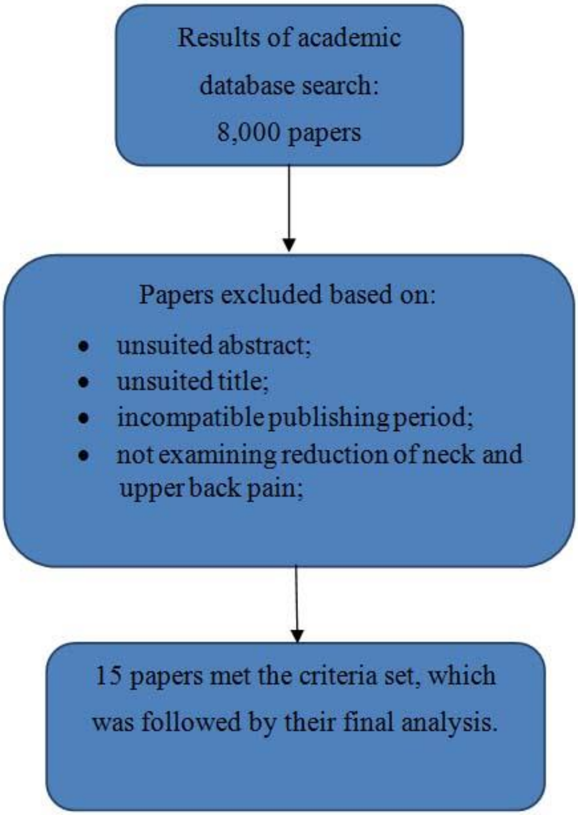

Table 1. Detailed analysis of the papers

Reference	Participant sample	Groups	Experimental program		Measuring instruments and results
			Frequency and duration	Exercise program	
Arshadi, et al., (2019)	A: EG: 21,44±2,06 CG: 20,14±1,71 S: m n=30	EG(n=15) CG(n=15)	TPD: 8 weeks WF: 3 times PD: 50 minutes	EG: Program comprised strengthening, stretching and stabilization exercises. I: 40% of 10RM	EG achieved sig.↑ better results compared to CG, and these exercises can bring about positive effects on UCS.
Kang, et al., (2018)	A: EG1: 31.8 ± 7.5 EG2: 33.8 ± 4.8 S: m, f n=30	EG1 (n=15) EG2 (n=15)	TPD: 4 weeks WF: 3 times PD: 30 minutes	EG1- scapula stabilization exercises EG2: neck stabilization exercises	EG1: sig.↑ better CVA results compared to EG2. Results show no sig.↑ for CRA between groups.
Kong, et al., (2017)	A: 21.6 ± 1.9 S: m, f n=32	EG1 EG2 EG3	TPD: 4 weeks WF: 5 times PD: EG1: once daily EG2: 2 times per day EG3: 3 times per day	EG1, EG2, EG3: modified exercises for cervical back	All three groups showed sig.↑. Group 3 had best results.
Park, et al., (2014)	A: EG: 13.55±2.21 2EG: 13.75± 1.80 S: m, f n=40	EG(n=20) CG(n=20)	TPD: 6 months WF: 3 times	EG- muscle stretching and strengthening exercises CG- no exercise	EG: Results show sig.↑ across all measurements compared to CG .
Harman, et al., (2005)	A: EG: 38.4 ± 11.3 CG: 36.9 ± 9.5 S: m, f n=40	EG(n=23) CG(n=17)	TPD: 10 weeks WF: 4 times	EG- home exercise program consisting of two stretching and two muscle strengthening exercises CG – no exercise/activity program	EG achieved sig.↑ in before/after testing, with results showing that home exercise can bring about positive results.
Ali, et al., (2017)	A: EG1: 20-50 EG2: 20-50 S: m, f n=52	EG1 EG2	PN: 16 WF: 3 times	EG1 – muscle energy technique (MET), isometric and stretching exercises	Results presented via NPRS, NDI and G show sig. ↑ for both groups; however, EG1

				EG2 – stretching exercises	showed sig.↑ compared to EG2
Kim, et al., (2016)	A: EG: 20,8±0,8 S: M: n=6 F: n=6 n=12	EG(n=12)	SN: 3 RN: 15 EN: 7	EG- exercise program with resistance bands	EG: sig.↑ for PM, sig.↑ for FSA, CVA, UT; other measurements do not show sig.↑.
Bae, et al., (2016)	A: EG: 22.1±2.3 CG: 24.3±2.9 S: m n=30	EG(n=15) CG(n=15)	TPD: 4 weeks WF: 3 times	EG- strength exercises for lower and middle trapezius, and stretching exercises or upper trapezius and levator scapulae CG – no exercise program	EG: DITI shows sig.↑ compared to CG, as do before/ after measurement results within EG.
Choi, et al., (2018)	A: EG: 22.5 ± 0.2 CG: 20.8 ± 0.3 S: m, f n=30	EG(n=15) CG(n=15)	TPD: 4 weeks PD: EG:10 mins CG:10 mins WF: 3 times	EG-interferential current therapy (ICT), FHP group CG- interferential current therapy (ICT), NHP group	Both groups showed sig.↑, therefore electrical stimulation can be included among treatments.
Lee, et al., (2017)	A: 19+ n=28	EG1(n=9) EG2(n=10) EG3 (n=9)	TPD: 8 weeks PD: EG1:25 min EG2:25 min EG3:25 min WF: 3 times	EG1- Corrective McKenzie exercise group EG2- Self-stretch exercise group EG3: Kendall exercise group	All 3 groups achieved sig.↑ improvement, with no sig.↑ between groups.
Im, et al., (2016)	A: EG: 35.5±8.8 CG: 35.7±9.8 S: m, f n=15	EG(n=8) CG(n=7)	EG: TPD: 4 weeks PD: 30 min WF: 3 times	EG- scapular stabilization exercises CG- relaxation exercises during same period	EG: WHOQOL-BREF sig.↑, VAS sig.↑, NDI sig.↑, CVA sig.↑, MVC sig.↑ compared to CG.
Kang, (2015)	A: EG: 23.9±3.3 CG: 23.1±3.1 S: m, f n=20	EG(n=10) CG(n=10)	TPD: 6 weeks WF: 3 times EG: +5-10 min PBU exercise	EG- deep cervical flexor training using pressure biofeedback unit CG- conventional deep cervical flexor training I: (RPE, Borg's 6–20 Scale)	Both groups showed sig.↑ in before/after testing. EG: DCF and cervical ROM sig.↑ compared to CG.

Andersen, et al., (2013)	A: EG1: 41 EG2: 43 EG3: 44 CG: 42 S: f n=118	EG1 (n=20) EG2 (n=25) EG3 (n=24) CG (n=49)	TPD: 20 weeks WF: 3 times RN: 8-20 SN: 4-12 EN: 5	EG1,EG2,EG3: neck/ shoulder strength training EG1: low practice frequency EG2: medium practice frequency EG3: high practice frequency CG: no training	EG2 and EG3: VAS sig.↑ compared to EG1 and CG.
Ahmadi,et al., (2019)	n=30	EG(n=14) CG (n=16)	TPD: 8 weeks	EG- aquatic exercise program CG- no exercise	EG: VAS sig. ↑ compared to CG. Results indicate that aquatic exercise can have beneficial effect on UCS.
Rostamizalani , et al., (2019)	n=30	EG1 EG2 EG3	TPD: 8 weeks	EG1: corrective exercise program for upper and lower extremities EG2: corrective exercise program for upper extremities EG3: corrective exercise program for lower extremities	Results show sig.↑ across all groups. EG1: sig.↑ compared to other 2 groups.

A-age; S-sex; M-male participants; F-female participants; sig.↑- statistically significant result improvement; n-number of participants; EG1-first experimental group; EG2-second experimental group; EG3-third experimental group; CG-control group; UCS –Upper crossed syndrome; TPD-total program duration; WF-weekly frequency; PD-individual practice session duration; I – intensity; RM–maximum number of repetitions with a given load; PN- number of practice sessions; SN – number of sets; RN – number of repetitions; EN – number of exercises; VAS-visual analog scale for pain assessment; MET- muscle energy assessment technique; NPRS–numeric pain rating scale; NDI–neck disability index; G - Goniometer; PM–pectoralis major assessment; FSA–forward shoulder angle; FHA–forward head angle; CVA- cranio-vertebral angle; CRA –cranial rotation angle; DITI – digital infrared thermal imaging; UT– upper trapezius; WHOQOL-BREF – World Health Organization's quality-of-life assessment; MVC– maximum voluntary contraction; PBU–pressure biofeedback unit; DCF– deep cervical flexor assessment; Borg's Scale–rating of perceived exertion; NHP –normal head position; FHP –forward head position.

Based on the data presented in Table 1, we can see that 9 studies featured a mixed sample, that is, included participants of both sexes. Two studies included all-male participants (Arshadi, *et al*., 2019; Bae, *et al*., 2016). One study included all-female participants (Andersen, *et al*., 2013), while two of the studies provided no information on the participants' sex.

The largest participant sample, at 118, is found in the study by Andersen and colleagues (Andersen, *et al*., 2013). The smallest participant sample was 12, in the study by Kim and colleagues (Kim, *et al*., 2016). The oldest participant samples were featured in the study by Andersen and colleagues, where the average age was 41-44, and in the study by Ali and colleagues, with an age range of 20 to 50 (Andersen, *et al*., 2013; Ali, *et al*., 2017). The study by Park and colleagues featured the youngest participant sample (Park, *et al*., 2014). The average age of participants in this study was 13. Most papers, namely 8 of them, included one experimental and one control group (Arshadi, *et al*., (2019); Kang, *et al*., (2018); Park, *et al*., (2014); Harman, *et al*., (2005); Bae, *et al*., (2016); Choi, *et al*., (2018); Im, *et al*., (2016); Kang, (2015); Ahmadi, *et al*., (2019)). Three papers included three experimental groups (Kong, *et al*., 2017; Lee, *et al*., 2017; Rostamizalani, *et al*., 2019). Studies by Kang and colleagues and Ali and colleagues included two experimental groups each (Kang, *et al*., 2018; Ali, *et al*., 2017). One study featured only one experimental group (Kim, *et al*., 2016), and another study featured 3 experimental and one control group (Andersen, *et al*., 2013). Study timeframes ranged between four weeks and six months. The longest duration of the experimental program was 6 months (Park, *et al*., 2014), while the shortest, featured in 5 papers, was 4 weeks (Kang, *et al*., 2018; Kong, *et al*., 2017; Bae, *et al*., 2016; Choi, *et al*., 2018; Im, *et al*., 2016). Weekly frequency of the practice/treatment was most often 3 times per week, while in the study by Kong and colleagues (Kong, *et al*., 2017) the weekly frequency included 5 practices/treatments. The duration of each individual practice/treatment session was in the range of between 10 and 50 minutes.

In assessing the progress and efficiency of their programs, each study applied specific scales and questionnaires, such as for pain assessment, for increasing participants' range of motion, or for measuring specific angles.

In the study by Kang and colleagues (Kang, *et al*., 2018), participants in the first experimental group attained greater result enhancements when results were presented by measuring the cranio-vertebral angle (CVA), whereas assessment of the participants' cranial rotation angle (CRA) established no difference between the two groups' progress. The study by Kong and colleagues (Kong, *et al*., 2017) found that results improved for all groups, with the greatest increase in range of motion (for CVA) achieved by the group with the greatest practice frequency. In the study by Park and colleagues (Park, *et al*., 2014), the results of the applied program indicate a significant reduction both in the angle of the head positioned forward and in the angle of forward rounded shoulders, as well as a reduction in lumbar lordosis. Furthermore, the applied exercise program improved the participants' flexibility. The exercise program applied in the study by Ali and colleagues (Ali, *et al*., 2017) brought about positive results in terms of the neck disability index (NDI), measured in this study. The study also examined the range of motion of the neck, and found that the exercise program led to an improvement in the range of motion of cervical flexion and extension, that is, bending the head forward toward the chest and backward to look upward. The study by Kim and colleagues (Kim, *et al*., 2016), which determined the condition of the participants and their progress by measuring the range of motion, that is, the CVA and forward shoulder angle (FSA), found positive effects of the exercise program using resistance bands. The study by Bae and colleagues (Bae, *et al*., 2016) found changes in body temperature, measured using a device for digital infrared thermal imaging (DITI); consequently, we have an insight into the condition of the participants in the experimental group, achieving positive results compared to the control group. In the study by Lee and colleagues (Lee, *et al*., 2017), the positive effects of exercise on posture were presented through measuring the range of motion, that is, the cranio-vertebral angle and scapular index measurements. The study by Im and colleagues (Im, *et al*., 2016) found positive results for participants in the experimental group. The results were tested using the quality-of-life assessment questionnaire (WHOQOL-BREF), neck disability index, cranio-vertebral angle, as well as the visual-analog scale for pain assessment (VAS). In the study by Kang (2015), neck mobility was measured using an instrument for measuring cervical range of motion, in addition to measuring the cranio-vertebral angle of all participants. The results indicated progress, namely an increase in the range of motion in the experimental group. The studies conducted by Anderson and Ahmadi and colleagues (Andersen, *et al*., 2013; Ahmadi, *et al*., 2019) demonstrate that participants had made progress, with the results being analyzed and processed using the scale for visual-analog assessment of pain. In Rostamizalani and colleagues (Rostamizalani, *et al*., 2019), the participants underwent improvement to their condition in terms of quality of life, as well as progress regarding the decrease of the angle of the head tilted forward.

DISCUSSION

The years when the studies analyzed were published indicate that the effects of different exercise programs on upper crossed syndrome have been the subject of more intensive research in more recent years.

A majority of the studies featured both male and female participants, indicating that issues with the neck and upper back can occur in both sexes.

Based on the participants' age, we conclude that upper crossed syndrome occurs both among middle-aged persons and in the younger population, which can be linked to the modern way of living and the use of technology.

With regard to research design, that is, in terms of the number of experimental and control groups, the papers analyzed can be divided in 2 groups, where one comprises studies including one control and a minimum of one experimental group. We have nine such papers (Arshadi, *et al*., 2019; Park, *et al*., 2014; Harman, *et al*., 2005; Bae, *et al*., 2016; Choi, *et al*., 2018; Im, *et al*., 2016; Kang, 2015; Andersen, *et al*., 2013; Ahmadi, *et al*., 2019). The remaining studies did not include a control group, featuring instead only experimental groups. Three papers included 3 experimental groups each (Kong, *et al*., 2017; Lee, *et al*., 2017; Rostamizalani, *et al*., 2019), comparing different exercise programs and systems. The study by Kong and colleagues (Kong, *et al*., (2017) featured 3 groups undergoing an exercise system, with the difference that one group exercised only once a day, the second group exercised 2 times a day, while the third one exercised 3 times a day. Although all groups showed progress, the results favored the groups with a higher exercise frequency. The exercises were done in 3 sets, where one set consisted of performing the exercise for 7 seconds, followed by a 10-second rest interval.

Moreover, regarding the relationship between practice frequency and results achieved, the study by Andersen and colleagues (Andersen, *et al*., 2013) demonstrates that higher practice frequency is accompanied by better results at the end of the program, indicating that exercise programs should be planned and programmed in this manner. This paper had one control and 3 experimental groups, where higher frequency of practice sessions was attended by participants' progress. The groups did 4 specific neck and shoulder exercises and one forearm exercise, with 8-20 repetitions in 4-12 sets. The experiment implemented the principle of progressive overload.

The study by Lee and colleagues (Lee, *et al*., 2017) featured three exercise systems/ programs, and all three groups achieved positive results. The first group performed the exercise (the McKenzie exercise) consisting of 7 movements for the duration of 7 seconds of static stress, followed by a 3-second rest. These exercises were done 20 times. Each stretching exercise in the second group was done in 10 sets, with a 10-second hold followed by a 5-second rest interval. Kendall's strengthening and stretching exercises, done by the third group, were repeated 15 times.

In the study where all groups achieved positive results (Rostamizalani, *et al*., 2019), the group which implemented the program targeting both the upper and lower extremities achieved better results compared to groups doing exercise targeting only the upper or only the lower extremities. In the studies featuring two experimental groups (Kang, *et al*., 2018; Ali, *et al*., 2017), each group achieved positive results. Each group had its own exercise program, and did exercises for neck or scapula stabilization (Kang, *et al*., 2018), or a combination of stretching and isometric exercises (Ali, *et al*., 2017). The participants in the study conducted by Kang and colleagues (Kang, *et al*., 2018) performed scapular stabilization exercises in 3 sets of 10 repetitions each, with each activity lasting three seconds. Cervical stabilization exercises were done for 10 seconds, with 10 repetitions across 3 sets.

Stretching exercises were done for 8-20 seconds in the study by Ali and colleagues (Ali, et al., 2017), while isometric exercises were done for 5-10 seconds.

Kim and colleagues conducted a study where the participants underwent an exercise program using resistance bands, which was followed by improved results (Kim, *et al.*, 2016). The seven exercises implemented in this study included: a lat pull-down, external shoulder rotation exercise, horizontal shoulder abduction exercise, seated bend row, shoulder abduction, shoulder flexion, and shoulder extension exercise.

In eight studies (Arshadi, *et al*., 2019; Park, *et al*., 2014; Harman, *et al*., 2005; Bae, *et al*., 2016; Choi, *et al*., 2018; Im, *et al*., 2016; *Kang*, 2015; Ahmadi, *et al*., 2019) there was one experimental and one control group, and throughout the implemented exercise programs had a positive effect both on UCS overall, and on its parts.

The program comprising strength, stretching and stabilization exercises found in the study by Arshadi and colleagues (Arshadi, et al., 2019), as well as the implemented exercise program for stretching and stretching the muscles in the paper by Park and colleagues (Park, *et al*., 2014), had a positive effect on UCS. In the paper by Park and colleagues (Park, *et al*., 2014), the stretching exercises (neck, back and shoulder stretching) were done in 3 sets of 10 seconds each. The strength exercises (isometric neck pulls, push-ups, forward bends, leg raises and extensions using a resistance band) were performed with a volume of 10-30 repetitions in 3 sets.

In the study by Arshadi and colleagues (Arshadi, *et al*., 2019), the stretching exercises are initially done for 30 seconds, extended by another 5 seconds after two weeks. The stabilization exercises were initially performed in 6 repetitions, held for 2 seconds, gradually increased to 10 repetitions with a 10-second hold. The strength exercises were performed at a volume 40% of the intensity of 10RM (RM – repetition maximum; thus, the maximum amount of weight one can lift 10 times), with a 10% increase every two weeks.

The study by Im and colleagues (Im, *et al*., 2016) comprised 5 stages, where each stage had 3 cycles of performing the exercises in 10 repetitions, with a 30-60 second rest interval in between. Holding a particular position lasted for 10 seconds. Scapular stabilization programs, or exercises, are also more beneficial compared to relaxation programs, as confirmed in this paper by Im and colleagues (Im, *et al*., 2016).

The program of exercises which can be performed at home also effected positive results. Harman and colleagues (Harman, *et al*., 2005) demonstrated the positive effects of this type of exercise program, consisting of strength and stretching exercises performed over 10 weeks. With a frequency of 4 practice sessions per week, the strength exercises were performed in 3 sets of 12 repetitions, while stretching exercises had the duration of 30 seconds in 3 sets. Strength exercises included shoulder retraction and the strengthening of deep cervical flexors, while stretching targeted cervical extensors, as well as chest muscles.

The study by Bae and colleagues (Bae, *et al*., 2016) found beneficial effects of exercises aimed at lower and middle trapezius, as well as of exercises aimed at stretching the upper trapezius and levator scapulae. All exercises were performed in 10 sets with 3 repetitions lasting 10 seconds each, with a 5-second rest interval between each repetition.

Electrotherapy is another possible way of coping with the issues caused by UCS. One of the studies (Choi, *et al*., 2018) showed that interferential current therapy can also be included among the treatments that can aid the battle against this syndrome.

The implemented exercise programs focusing on deep cervical flexors showed significant results (Kang, 2015), while the study conducted by Ahmadi and colleagues (Ahmadi, *et al*., 2019) demonstrated that aquatic exercise also merits being included among training plans and programs that may have a positive effect on UCS.

Regarding the efficiency of the implemented exercise programs, considering program duration and weekly frequency, the results of the analyses indicate that the most efficient exercise programs were those implemented in the studies by Arshadi and colleagues, Bae and colleagues, Lee and colleagues (Arshadi, *et al*., 2019; Bae, *et al*., 2016; Lee, *et al*., 2017).

The exercise programs that gave the best results and that are therefore recommended for correcting the postural disorder – upper crossed syndrome, were those whose duration was a minimum of 4 weeks, with a minimum training frequency of 3 practice sessions per week. These programs included a combination of strength and stretching exercises.

In view of the results obtained with the implemented programs, programs recommended for the correction of this syndrome include those with a frequency greater than three practice sessions per week, as was the case in the studies by (Arshadi, *et al*., 2019; Kang, *et al*., 2018; Kong, *et al*., 2017; Park, *et al*., 2014; Harman, *et al*., 2005; Bae, *et al*., 2016; Lee, *et al*., 2017; Im, *et al*., 2016; Kang, 2015; Andersen, *et al*., 2013).

Regarding the duration of the program itself, those studies which implemented shorter durations (Kang, *et al*., 2018; Kong, *et al*., 2017; Bae, *et al*., 2016; Choi, *et al*., 2018; Im, *et al*., 2016) achieved positive results, as did those with a longer duration. Still, programs with a minimum duration of 4 weeks should be given preference.

With regard to type of exercise, a majority of studies implemented a combination of strength and stretching exercises (Park, *et al*., 2014; Arshadi, *et al*., 2019; Harman, *et al*., 2005; Ali, *et al*., 2017; Kim, *et al*., 2016; Bae, *et al*., 2016; Lee, *et al*., 2017; Andersen, *et al*., 2013; Rostamizalani, *et al*., 2019; Ahmadi, *et al*., 2019; Im, *et al*., 2016).

The most frequently implemented strength exercises included weight exercises and bodyweight exercises, where training loads were gradually increased over the course of the program.

The implemented exercises were administered primarily by volume, rather than by intensity. Training volume which had a positive effect consisted of a minimum of three sets per exercise, and no less than eight repetitions. Starting with such a program volume will bring about positive results, on condition that the remainder of the program follows the principle of progressive overload.

Considering strength exercises individually, they included exercises for the strengthening of the back, the middle and lower trapezius, rhomboid muscles, as well as deep cervical flexors. The exercises applied in the studies (Kim, *et al*., 2016; Harman, *et al*., 2005; Arshadi, *et al*., 2019; Bae, *et al*., 2016; Lee, *et al*., 2017), and consequently those most recommended for muscle strengthening, include: lat pull downs, rowing exercises using machines and/or props (seated bend row, rowing exercises using weights or resistance bands), bodyweight corrective exercises on the floor, shoulder flexion, extension and abduction (rear lateral raises with dumbbells, face pulls using the apparatus or resistance bands).

Regarding the improvement of flexibility, the most used method was that of static stretching (Park, *et al*., 2014; Harman, *et al*., 2005; Arshadi, *et al*., 2019; Bae, *et al*., 2016; Lee, *et al*., 2017), stretching the chest muscles, as well as the upper trapezius and the levator scapulae. These exercises can be performed without the aid of props, in a standing, sitting or lying position. The recommended duration of an individual movement in static stretching is between 10 and 30 seconds.

CONCLUSION

The results of this systematic review indicate that, when it comes to upper crossed syndrome, various physical exercise programs affecting the strengthening and stretching of upper back and neck muscles can be applied. The studies analyzed used different exercise programs, such as strength exercises, stretching and stability exercises, exercises for cervical back strengthening, an exercise plan that can be realized at home, a stretching and isometry exercise program, resistance band exercises, interferential current therapy, relaxation exercises, aquatic exercise, as well as other corrective exercise having a beneficial effect on this syndrome.

Based on the overall analysis, recommended exercise programs include programs for strengthening weakened musculature, or for stretching strained musculature, over a period of a minimum of 4 weeks, with a weekly frequency of 3 practice sessions.

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ЕФЕКТИ ПРОГРАМА ВЕЖБАЊА НА ГОРЊИ УКРШТЕНИ СИНДРОМ: СИСТЕМАТСКО ПРЕГЛЕДНО ИСТРАЖИВАЊЕ

САЖЕТАК

Дуготрајно задржавање истурене главе напред може проузроковати настанак постуралног поремећаја под називом горњи укрштени синдром – ГУС. Горњи укрштени синдром дефинише се као пренапрегнутост односно затегнутост горњег трапезијуса, великог грудног мишића и леватора скапуле, а представља и слабост ромбоидеуса, сератус антериора, средњег и доњег дела трапезијуса, као и дубоких флексора врата. Оваква постура може изазвати болове у врату, односно болове у горњем делу леђа. Синдром се погоршава са напретком у технологији и све већом употребом рачунара и паметних телефона. Неповољно утиче на децу школског узраста, на студенте, као и на раднике који свој посао обављају у неприкладном положају и понављају једне те исте радње током свог радног дана. Физичко вежбање односно вежбе снаге и истезања представљају један од могућих начина за корекцију овог постуралног поремећаја. С тим у вези циљ овог истраживања је да се на основу систематског прегледа досадашњих истраживања утврде ефекти примене различитих програма вежбања на третман горњег укрштеног синдрома. Анализирани научни радови, прикупљени су претраживањем интернет база података електронских издања научних часописа: Google Scholar, PabMed, WoltersKluwer. Претарживани радови су објављени у временском периоду од 2000. до 2019. године. Кључне речи које су коришћене за претраживање база података су горњи укрштени синдром, ефекти, програм вежбања. Истраживања су била прихваћена на основу следећих критеријума: да се испитује утицај различитих програма вежбања на горњи укрштени синдром, затим на смањење бола у врату и горњем делу леђа и на повећање функционалних способности. На основу постављених критеријума у коначну анализу је ушло 15 радова. Коначном анализом утврђено је да најбоље ефекте на горњи укрштени синдром имају радови коју су у својим програмима садрже вежбе снаге и истезања, у временском периоду од 4 недеље, са минималном недељном фреквенцијом од 3 тренинга.

Кључне речи: Горњи укрштени синдром, тренинг, снага, флексибилност

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ВЛИЯНИЕ ПРОГРАММЫ УПРАЖНЕНИЙ НА СИНДРОМ ВЕРХНЕГО СКРЕЩИВАНИЯ: СИСТЕМНЫЙ ОБЗОР

АННОТАЦИЯ

Удерживание головы в положении с выдвижением вперед может в конечном итоге вызвать нарушение осанки, называемое синдромом верхнего скрещивания - UCS. Синдром верхнего скрещивания определяется как гиперактивность или сжатие верхней трапециевидной мышцы, большой грудной мышцы и мышцы, поднимающей лопатки, в сочетании с ослабленной ромбовидной, передней зубчатой мышцей, средней и нижней трапециевидной мышцей, а также глубокими шейными сгибателями. Эта поза может вызвать боль в шее, а также в верхней части спины. Синдром усугубляется технологическим прогрессом и постоянно нарастающим использованием компьютеров и смартфонов. От него страдают дети школьного возраста, студенты вузов, а также сотрудники, которые работают в неправильной позе или повторяют многократно одни и те же действия в течение рабочего дня. Физические упражнения, а именно силовые упражнения и упражнения на растяжку, являются одним из возможных методов коррекции данного нарушения осанки. Таким образом, цель данного исследования – провести системный обзор современных исследований, чтобы определить как влияет выполнение различных программ упражнений на лечение синдрома верхнего скрещивания. Анализируемые научные статьи были найдены в онлайн-базах электронных академических журналов: Google Scholar, PubMed, Wolters Kluwer. Основное внимание в обзоре уделялось статьям, опубликованным в период с 2000 по 2019 год. Ключевые слова, использованные для поиска в базах данных, включали: синдром верхнего пересечения, влияние, программа упражнений. Исследования основывались на следующих критериях: изучение влияния различных программ упражнений на синдром верхнего скрещивания, а также на уменьшение боли в шее и верхней части спины и улучшение функциональных способностей. Руководствуясь установленными критериями, в окончательный анализ было включено 15 исследований. Окончательный анализ показал, что на синдром верхнего скрещивания наиболее благоприятно влияли программы, содержащие силовые упражнения и упражнения на растяжку, когда они выполнялись в течение 4-х недель и не менее 3 практических занятий в неделю.

Ключевые слова: синдромом верхнего скрещивания, тренировка, напряженность, подвижность.

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