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Effectiveness of postural corrective exercise on postural improvement in students with forward head posture (FHP)

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ABSTRACT

Background: Forward head posture (FHP) is a postural problem in the cervical area characterized by the position of the tragus in front of the plumb line in the sagittal plane with a craniovertebral angle (CVA) value <50°. This condition can be caused by work positions or activities that tend to look down for a long duration. Postural corrective exercise is one of the exercises that can improve posture.
Objective: Knowing the effectiveness of postural corrective exercise on posture improvement in students with FHP.
Methods: This study used a quasi-experimental pre & post-test design. Respondents were 68 students of Universitas 'Aisyiyah Yogyakarta with CVA <50° who were then randomly divided into 2 groups. namely Group A (postural corrective exercise) and Group B (self-postural corrective exercise). CVA measurement was performed using the On Protractor application.
Results: There was a significant increase in CVA after postural corrective exercise and self-postural corrective exercise treatment (p = 0.00). Postural corrective exercise is more effective in improving FHP posture than self-postural corrective exercise (p = 0.00).
Conclusion: Postural corrective exercise is more effective on posture improvement in students with FHP.

Keywords: craniovertebral angle (CVA), forward head posture (FHP), postural improvement, postural corrective exercise

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BACKGROUND

Forward head posture (FHP) is one of the most common postural problems on the sagittal side of the cervical area.[1] This condition is characterized by the position of the tragus which is in front of the plumb line in the sagittal plane of the body or the ear's position is more forward than the shoulder.[2,3] Based on Kawasaki et al, FHP can be seen by measuring the cranial vertical angle or craniovertebral angel (CVA), which is the angle between the line from the tragus to the C7 bone and the horizontal line at C7 with the interpretation it may indicate FHP if the CVA value is <50°.[4] This occurrence can be caused by equipment that is not ergonomic or appropriate, work positions or activities that tend to bow and long duration of bowing activities.[5-7]

The prevalence of FHP among university students is high. It was reported that the incidence of FHP was 76.1% of 213 students aged 10-20 years in Portugal, 63.3% of 150 students in India and 67% of 188 students in Malaysia.[8-10] Similarly, in Indonesia, the incidence of FHP was found to be 94.2% of 138 students in Pekalongan, 62.9% of 105 students in Bali and 70.1% of 87 students in Yogyakarta.[11-13] The high prevalence of FHP in students can occur because students are found in activity patterns in the form of static postures that tend to bow when using smartphones, laptops or computers whose use has become a habit and is even needed in the learning process.[14] The use of such equipment with a duration of more than 3 hours per day can increase the risk of FHP.[15] Whereas FHP have various long-term impacts on health, such as increased neck pain due to pressure on joints and lengthening of cervical ligaments, decreased respiratory ability due to changes in thoracal posture and pathological changes in respiratory muscles, and decreased balance due to changes in postural control.[16-20]

One of the physiotherapy interventions that can be given to FHP conditions is postural corrective exercise. Postural corrective exercise is an exercise that consists of two techniques, strengthening and stretching. In FHP case, this exercise focuses on strengthening and stretching the cervical muscles. In a study by El-Azeim et al. in Egypt, the application of postural corrective exercise to respondents aged 20-35 years with FHP conditions can improve CVA curves and neck functional abilities.[21] In addition, in a study conducted by Seidi et al. in Iran on men aged 18-28 years, it was proven that corrective exercise was effective in improving imbalance muscle activation, movement patterns and body alignment in conditions of upper crossed syndrome (UCS).[22] The study conducted by Shete & Shah in India on students with abnormal posture showed that postural corrective exercise combined with the use of ergonomic equipment was effective in improving abnormal postures such as FHP in chronic smartphone users.[23] In Indonesia, research about postural corrective exercise on postural improvement in forward head posture is still not widely done.

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The high risk and incidence of FHP in the current era is very worrying, coupled with the impact that can affect the quality of life of sufferers. This requires studies on the development of FHP treatment. Based on the explanation above, physiotherapy intervention in the form of postural corrective exercise is proven to help overcome problems in FHP conditions. But so far, there has been no study on the effectiveness of postural corrective exercise on posture improvement in students with FHP conditions in Indonesia. The purpose of this study was to determine the effectiveness of postural corrective exercise on postural improvement in students with forward head posture (FHP).

MATERIALS AND RESEARCH METHODS

This study used a quasi-experimental pre & post-test design. This study was approved by the Health Research Ethics Commission of Universitas 'Aisyiyah Yogyakarta (no. 2861/KEP-UNISA/V/2023).

RESPONDENTS

This study took 68 respondents using purposive sampling with the inclusion criteria of Universitas 'Aisyiyah Yogyakarta students, both male and female; doing activities that tend to bow the head > 5 hours per day, such as using gadgets, reading books and studying; having FHP posture with a CVA value <50° measured using the ON Protractor application; willing to participate in the research program by signing an informed consent sheet; and not currently receiving other postural treatments. Students with a history of surgery, spinal and vestibular disorders and who could not be cooperative were excluded. Furthermore, respondents were divided into two groups proportionally, by taking 8 students of the Physiotherapy Undergraduate Program, 9 students of the Nursing Science Undergraduate Program, 8 students of the Nutrition Undergraduate Program and 9 students of the Medical Laboratory Technology Program as representatives in each group. The placement of respondents into the treatment group was randomized.

EXERCISE PROCEDURE

Group A: Postural corrective exercise

The postural corrective exercise program used was Son's program.[24] This exercise was carried out guided by the researcher for 4 weeks with a frequency of 3 times per week (12 treatments). The equipment needed in this exercise is styrofoam dumbbell. The balance pad that should have been used in this exercise procedure had to be replaced using a foam mat due to the unavailability of a balance pad. The determination of the use of a foam mat was based on a reference journal from Son which states that the function of the balance pad in this exercise is for proprioceptive and balance training and Pancheva & Stambolieva which states that the use of a foam mat also has the same function.[24,25] The following exercise movements were performed.

a) *Squats*

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Respondents stood on a foam mat with their feet shoulder-width apart. Respondents were asked to lower their hips to knee level then hold for four seconds and stand back up. This movement is done for 5 minutes. However, because the respondents were still not used to this movement, they could not do it for 5 minutes immediately. Therefore, this movement was carried out interspersed with breaks for some time according to the respondent's ability.

b) XCO *training*

Respondents stood on a foam mat with their feet shoulder-width apart while holding styrofoam dumbbells in both hands. Respondents were asked to perform shoulder flexion movements or raise their hands on one hand while the other hand was straight down and held for 2 seconds. The movement is done alternately between right and left for 5 minutes.

c) *Chin tucks*

Respondents stood upright against a wall with their heels against the wall. Respondents were asked to perform chin tuck movements (attaching the chin to the neck while extending the neck) while keeping the head against the wall. This movement is done for 5 minutes.

Group B: Self-postural corrective exercise

The program applied was self-postural corrective exercise programmed by Gurudut, Welling & Chodankar.[26] This exercise was performed independently by the respondents. However, the researcher gave directions and guided the respondents to do this exercise before the first session was conducted so that the respondents clearly understood the exercise procedures that had to be done. Subsequently, the respondents performed the exercise independently. This exercise was carried out for 10 consecutive days with a frequency of 2 times per day (20 treatments). The equipment needed in this exercise is an elastic resistance band. Furthermore, the researcher conducted monitoring through WhatsApp private messages to each sample during the 10 days of treatment at least 2 times a day, namely in the morning and evening. The following exercise movements were performed.

a) *Bruegger's postural relief position*

The respondent sat with both legs hanging. An elastic resistance band was tied to the palms of both hands. The initial position of the respondent is that both arms are at the side of the body, both elbows are flexed and both palms are open and facing up. After that, both arms of the subject were diverted and both elbows were straightened simultaneously. Followed by extension movements in the wrist and all fingers. Then added with scapula retraction and shoulder extension movements. This movement was held for 10 seconds on the first day and increased to 30 seconds on the 10th day (increasing by 5 seconds every 2 days). This movement is performed 15 times per session with a 30-second rest period.

b) *Quadruped track cervical brace*

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The respondent is on all fours. The respondent raises the scapula towards the ceiling. Then proceed with the chin tuck movement (attaching the chin to the neck while keeping the neck straight) until there is a sensation of pulling on the cervical muscles. This movement is done by keeping the abdomen from curling down. This position is held for 30 seconds with a rest period of 30 seconds as well. This movement is repeated 3 times per session.

MEASUREMENT

Measurement of FHP posture was carried out by measuring the craniovertebral angle (CVA) of respondents using the ON Protractor android application as a measurement instrument. Measurements were carried out twice, namely at the beginning before receiving treatment and after receiving treatment, namely in the last session of week 4 for Group A and the day after day 10 in Group B. The measurement was carried out in a way that the respondent was positioned standing upright with a straight forward view and both hands were beside the body. Mark the tragus and processuss spinous cervical 7 (C7) then draw a line from the two marks and add a horizontal line from C7 to the anterior to make an angle.[27] The angle formed at C7 is the CVA value.

STATISTIC ANALYSIS

Data analysis was conducted using SPSS version 26.0 software. Normality test used Kolmogorov-Smirnov test. Lavene's test was used for homogeneity test. Furthermore, researchers used paired samples t-test to see the difference in CVA values between before and after treatment in both groups. Meanwhile, to see the difference between the two groups, independent t-test was used. Both tests were concluded to be significant if $p<0.05$.

RESULTS AND DISCUSSION

RESULTS

The respondents' characteristics in this study are shown in Table 1. below.

Table 1. Respondents' Characteristics

Characteristic	Group A (n=34)	Group B (n=34)
Downward activity *f* (%)		
Yes	34 (100)	34 (100)
Duration of head-down activity *f* (%)		
5 – 7 hours per day	12 (35,3)	3 (8,8)
>7 hours per day	22 (64,7)	31 (91,2)
CVA value *mean*±SD	39,66°±3,66	40,61°±4,84

All respondents in both groups performed activities that tended to bow in their daily activities (100%). Based on the duration of the bowing activity, most respondents fell into the category of duration >7 hours per day, namely 22 respondents (64.7%) in Group A and 31 respondents (91.2%) in Group B. In this study, the average CVA value in Group A was 39.66° ± 3.66 and in Group B was 40.61° ± 4.84.

The results of the normality test of pre and post-test CVA values in both groups show in Table 2. Shows normal results ($p>0.05$). The results of the homogeneity test in both groups in Table 3. show homogeneous data

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on the pre-test CVA value (p>0.05), but show inhomogeneous data on the post-test CVA value (p<0.05).

Table 2. Normality Test Result

Variable	Normality (*p* value)	
	Group A	Group B
CVA *pre-test*	0,20	0,20
CVA *post-test*	0,14	0,20

Table 3. Homogeneity Test Result

Variable	Homogeneity (*p* value)
CVA *pre-test*	0,30
CVA *post-test*	0,01

Table 4. shows the results of paired sample t-test in both groups. There was a significant increase in CVA values in both groups before and after treatment (p<0.05). Based on the results of the independent sample t-test in Table 5, there is a significant difference in the two groups in increasing the value of CVA pre and post-test (p<0.05) where Group A with treatment in the form of postural corrective exercise causes an increase in CVA value more.

Table 4. Paired Sample T-test Result Group A & Group B

Group	*Pre-test*	*Post-test*	*P* value
Group A	39,66°± 3,66	44,43°± 3,34	0,00
Group B	40,61°± 4,84	44,19°± 4,97	0,00

Table 5. Independent T-test Result

Group	Difference CVA	*P* value
Group A	4,77°±2,45	0,01
Group B	3,58°±1,07	

DISCUSSION

This study found that postural corrective exercise was significantly effective in increasing the value of CVA in students with FHP after 4 weeks of treatment where the average increase reached 4.77° (p=0.01). The effectiveness of this treatment can be caused by several effects, namely increased strength and flexibility of the cervical and shoulder muscles, improved proprioceptive function and balance and improved posture.

a) Increased Muscle Strength of the Cervical and Shoulder Area

Postural corrective exercise causes an increase in strength in the cervical area muscles that are weakened, such as the deep cervical flexor muscles. This can occur because this exercise requires contraction of the muscles of the body, especially postural muscles. The stimulation of the contraction causes the weakened muscles to be fully activated. Furthermore, the phase of holding the body in a certain position also causes these muscles to contract longer so that an adaptive motorneuron response arises that can increase the ability of muscles to contract more strongly.

This study is in line with research by Gumuscu, Kisa, Kaya & Muammer who reported that strengthening exercises for 45 patients with complaints of neck pain for 4 weeks can increase the strength of deep cervical flexor muscles. Strengthening exercises in the form of deep cervical flexor muscle training and core stabilization training make the deep cervical flexor muscles that experience weakness in FHP conditions become activated and their contractions increase. Correspondingly, the strength in the muscle also increased. As the muscle

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supporting the shape of the cervical lordosis curve, this muscle is an important stabilizer of head and cervical posture. Therefore, strengthening of the deep cervical neck flexor muscles is necessary for postural improvement in FHP. In addition, strengthening this muscle group has also been shown to reduce neck pain and improve neck ROM and functional ability.[28]

Reinforced by Lysenko, Vinogradova & Popov who said that when doing strengthening exercises, there is an adaptive response to the motorneuron system. The stimuli that appear when doing strengthening exercises make the activity of delivering impulses from the motor cortex neurons to the muscles increase. This causes an increase in muscle activity to contract which can be seen using electromyography (EMG). Furthermore, this activation can contribute to increasing muscle strength as well as cervical muscle strengthening exercises in this study.[29]

The resistance training on the thoracic vertebrae in the corrective exercise program in this study can increase the strength and endurance of the cervical muscles as in the research of Moon, Lee, Kim & Seo. Thoracic vertebrae are the supporting base of the cervical spine so that strengthening and stabilizing normal posture in the region will affect the position and movement of the cervical which in turn can lead to increased cervical muscle activity. That way the strength and endurance of the cervical muscles will increase.[30]

b) Increased Muscle Flexibility of the Cervical and Shoulder Area

Concentric contractions in cervical muscles that experience weakness cause lengthening and decreased activity in the antagonist muscles which can further increase the flexibility of these muscles. Lengthening of the antagonist muscles is necessary to allow movement to occur. In FHP conditions, the cervical muscles have unbalanced performance or what is called muscle imbalance. This causes one muscle group to experience weakness while the opposite muscle group experiences shortening. To deal with the muscle shortening problem, movement in the opposite direction of its function is required, namely by contracting the muscles that experience weakness.

Alizadeh et al. in their study reported that there is a possible neural adaptation response to static stretching exercises. In his research, after static stretching exercises for 3 weeks, there was a reduction in afferent tonic nerve feedback from the T and H reflexes on the muscle spindle. This causes a decrease in stimulation of the contraction reflex so that the muscle relaxes and subsequently muscle flexibility will increase. In line with the current study where static stretching occurs in the upper cervical extensor muscles and suboccipital muscles. In FHP conditions, these muscle groups experience shortening so that by doing this stretching exercise these muscle groups will be stretched.[31]

Park & Lee's research reported that corrective exercise with hand lifting

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movements can reduce activity in the sternocleidomastoid, splenius capitis, deltoid, upper trapezius, serratus anterior, pectoralis major and infraspinatus muscles which in FHP conditions experience shortening due to excessive work. When performing movements in this exercise program, the body is in the proper position so that the work of all muscles is balanced and reduces contraction or activity in these muscles. A decrease in muscle contraction affects muscle length so that muscle flexibility can increase.[32]

In addition, Mehri, Letafatkar & Khosrokiani who also conducted research on the effect of corrective exercise on posture found that corrective exercise treatment had the effect of reducing the activation of the upper trapezius muscle. In FHP conditions, the upper trapezius muscle is one of the muscles that experience shortening due to excessive activation. The cervical deep flexor muscle strengthening exercises contained in corrective exercise in addition to causing strengthening in the muscle group can also provide a neural adaptation effect to increase the activation of more motor units so that their use is more effective and evenly distributed. This can minimize the activity of the upper trapezius muscle and reduce the risk of muscle shortening.[33]

c) Improvement of Proprioceptive Function and Balance

The postural corrective exercise program not only applies static exercises, but also dynamic exercises in the form of squats that cause body movement and displacement of the center of gravity. This dynamic exercise not only provides strengthening of postural muscles and lower limbs, but also stimulates the body's proprioceptive system to be able to bring up motor control to adapt and maintain body position to stay balanced. The use of a mat as a fulcrum or foothold when doing squats causes uneven footing and will stimulate the proprioceptive system including the proprioceptive system in the cervical area.

Son in his research that applied the same postural corrective exercise program as this study reported that there was an increase in balance in his respondents who were students in Busan, South Korea. The existence of proprioceptive exercises in the form of dynamic exercises in squats and the use of balance pads that make uneven footing causes adaptation of the proprioceptive system to maintain posture so that static and dynamic balance increases. The increase was also followed by improved posture in the vertebrae, including in the cervical area.[24]

Furthermore, it is reinforced by Elpeze & Usgu's research which says that proprioceptive improvements are needed in an effort to improve vertebral posture. Proprioceptive improvement can occur through dynamic exercises. Proprioceptive improvement is considered to increase postural awareness which in turn can make individuals more concerned about their posture and apply correct posture in daily activities. This is evidenced by the results of his research which showed that along with the improvement of vertebral posture there was

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also an increase in proprioceptive and balance of respondents after receiving treatment in the form of a comprehensive corrective exercise program (CCEP) for 12 weeks.[34]

As for Pancheva & Stambolieva who said that proprioceptive training using a foam mat as a foothold can improve proprioceptive function and postural balance, both static and dynamic, in patients post anterior cruciate ligament (ACL) reconstruction. Standing on unstable footing on a foam mat causes a reorganization of proprioceptive input mechanisms, especially at the sole receptors. Thus, afferent nerves in the somatosensory system work harder to keep the base of support at the center of the body and regulate efficient postural balance.[25]

d) Posture Improvement

Strengthening the weak muscles and stretching the shortened muscles in the cervical area in postural corrective exercise provides a sustainable effect in the form of cervical posture improvement. This may occur because the performance and activation of all cervical area muscles during this exercise becomes balanced. Neuromuscular adaptation to this exercise will then change the cervical posture to a normal position so that the CVA value is reduced. In addition, the presence of proprioceptive and balance exercises in this exercise program also makes the activation of postural muscles and proprioceptive systems in the vertebrae and lower limbs more thorough. Postural muscles that have mutual influence on each other make the effect of posture improvement more optimal. With a good proprioceptive system and muscle activation throughout the body, good posture, including in the cervical area, can be better maintained.

Alizadeh et al. in their study reported that after corrective exercise treatment for 8 weeks, there was an improvement in the cervical curve in FHP conditions. This can be achieved because when doing corrective exercise, the body is positioned in the right position so that there is an increase in neuromuscular efficiency and an increase in motor control strategies in the deep cervical flexor muscles. This condition then causes minimization of activation in the superficial cervical muscles as well as strengthening of the weakened muscles so that muscle work becomes balanced, cervical position becomes normal and compression on the cervical joints and underlying vertebrae is reduced.[33]

The postural corrective exercise program in this study also contains squats. According to Kohn, Smith & Goble, squats aim to train the strengthening of body muscles, including the gastrocnemius, quadriceps, hamstrings, gluteus maximus and postural muscles (core musculature), especially in the back and abdominal parts. The main purpose of squats in this study was to activate the muscles in the cervical area.[35] Based on Xue, Kim & Kim's research, head position and direction of view are important aspects of doing squats. The results showed that head position and direction of view affect the location of the center of pressure (COP) and muscle work. In a normal or neutral head

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position with the direction of view straight ahead, the location of the COP is balanced on the entire sole of the foot. Whereas in the position of the head leaning back with the direction of view up will move the location of the COP greater on the back of the foot and in the position of the head leaning forward with the direction of view down will move the location of the COP greater on the front of the sole of the foot. The incorrect location of the COP on the entire surface of the sole of the foot will cause the risk of falling to increase, making it prone to injury. Therefore, the position of the head when doing squats is recommended in a neutral position. Thus, the application of squat exercises in FHP conditions is beneficial to activate the muscles in the cervical area in order to maintain the head in a neutral position.[36]

In addition, results in the study of Hlaing, Puntumetakul, Khine & Boucaut showed that the same core stabilization exercise targeting postural stabilization muscles as in the squats exercise in this study can improve body balance after 4 weeks of treatment. This exercise causes increased activation of postural muscles, such as the lumbar multifidus and transversus abdominis muscles. When doing this exercise, there will be stimulation of muscle fibers and vertebral joint receptors so as to improve the accuracy of sensor motor integration and initiate joint repositioning in the right direction. Postural muscles such as the lumbar multifidus and transversus abdominis have a rich source of sensory input. The relearning of postural muscles to be in a normal position plays an important role in maintaining postural control. This leads to increased somatosensory processing that restores kinesthetic awareness, improves proprioceptive and balance abilities.[37]

As for Dawood et al. who argue that proprioceptive in the upper cervical area is very sensitive to changes in postural alignment and works together with the vestibular system to maintain equilibrium and body balance. In addition, the muscles in the cervical area have a large number of mechanoreceptors that play an important role in transmitting information about balance. Therefore, balance or proprioceptive training also improves proprioceptive abilities in the cervical area which play an important role in the performance of cervical muscles. With the increase in cervical proprioceptive ability, activation or performance of the cervical muscles will be maximized, one of which is in maintaining posture, so that it will cause improvements in cervical posture.[38]

CONCLUSION

This study concludes that postural corrective exercise is significantly effective in improving posture in students with FHP. The application of this exercise program provides various positive effects that can optimize the improvement of FHP posture. Suggestions for further researchers are to be able to carry out comprehensive control and supervision of respondents' activities that can affect the cervical curve so that the results of curve

improvements obtained from the provision of treatment can be more optimal.

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