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The targeted rehabilitation program with corrective exercises on trainable mentally handicapped people with upper body disorders

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Abstract

Background: Community-based rehabilitation is a multi-dimensional approach to improve the function and quality of life to mentally ill people.

Aim: This study examined the effect of rehabilitation protocol that were the spine strengthening exercises on adult mentally disabled men with upper body anomalies.

Materials and Methods: This study was performed on 28 educable mentally disabled with the age range of 30-45. These subjects had positional hyperkyphosis angle, more than 45° and FHP more than 46°. They were randomly divided into two groups of experimental (n=16) and control (n=12). Experimental group followed the three-step training protocol for two months. A spinal mouse and a digital camera were used to measure the deviation of thoracic area's hyperkyphosis and the FHP angle respectively. The dependent and independent t-tests were applied for within and between groups' comparisons respectively. The significance level was considered at 0.05, all analysis of study was done by $SPSS_{23}$.

Results: The mean of hyperkyphosis and FHP angles in experimental group, significantly decreased (*P*= 0.008, 0.003), respectively. But there was no significant change in control group (*P*= 0.101, 0.122). The independent t-test results for both variables indicated a significant difference between control and experimental subjects after the protocol (*P*= 0.001).

Conclusion: The combined corrective exercises caused a reduction in head, neck and trunk disorders of study subjects.

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1. Introduction

Mental disability is characterized by a level of intelligence which is less than average or it is known as a lack of mental ability and necessary skills for daily life [1]; so, a person with IQ score of less than 70- 75 is considered as mentally handicapped individual. The mental disability affects almost 1% of world's population; and about 85% of these affected people suffer from mild disability while the others have severe ones [2]. These people have lower physical activity than healthy individuals, because of their mental and psychological conditions and society's attitude towards them [1, 2]. They also have higher death rate, due to the diseases caused by inactivity and structural changes. Some of these disabled individuals are trainable; but choosing the right methods is very important to educate them and to maintain their physical structure, because these people suffer from severe structural disorders and physiological diseases which is due to their special conditions [3].

Kyphosis is one of these disorders and it refers to a complication that happens with an increase in forward curvature of the spine along the sagittal plate [4]; and an abnormal increase of dorsal arch, to more than 40° is defined as hyper kyphosis [5].

Hyper kyphosis is a common postural disorder and it is an important factor which affects the pathology of upper body. Its most obvious symptom is a back hump; and it causes a range of problems such as shoulder pains and spine fractures [6, 7]. The affected people usually show some side effects such as mild to severe backache, fatigue, pain with improper movement, increase of head's forward position and uneven shoulder height. In more severe cases, the suffering people may also have pain in thorax area, asthma, weakness or loss of feeling and intestine or bladder incontinence [8, 9]. The prevalence of this complication is reported as, 15.3% in 11-years-old children, and 38% in people aged 20 to 50 years, in various studies [10, 11].

Forward head posture complication (FHP) is a disorder which is completely relative to kyphosis and it can also affect the mentally disabled individuals. It is recognized by checking the position of head relative to cervical spine. This abnormality causes the pressure of head on cervical vertebrae from the anterior part, and the tilting of head in posterior direction causes an excessive increase of pressure in the upper cervical vertebrae. The rotation of head towards back on the cervical vertebrae in people with FHP causes them to look straight ahead instead of looking to the ground. If this complication gets chronic, it makes much pressures on the muscles and connective tissues of cervical vertebrae [12]. FHP, limits the movements of body, due to the muscle's excessive underactivity or over activity, just the same as other postural and motor disorders. The deep neck flexors, erector spine of neck area, lower trapezius and rhomboids are the muscles which mostly tend to be underactive in people with FHP; the underactivity of these muscles causes an inability for keeping the upright position of cervical vertebrae. On the other side, the muscles which often become overactive in people with FHP, include upper trapezius, levator scapula, scalenes, sternocleidomastoid and suboccipitals. The hyperactivity of these muscles causes the forward move of head and in some cases, it leads to the roundness of shoulders [13].

In the severe cases of FHP, the upper part of cervical vertebrae may be compressed, which can significantly reduce the rotation ability of first cervical vertebrae

around the second vertebrae. When the upper part of cervical vertebrae loses its rotation ability, the middle and lower parts of this segment must compensate this limitation, which makes them to go beyond the normal range of motion. This compensatory motion can increase the risk of spinal instability, weakness and pain of head and neck [14].

Kyphosis and FHP complications can be treated by invasive (surgical) or non-invasive methods. Although the non-invasive methods are more emphasized in their management, but surgical treatment is also used in structurally resistant cases or when non- surgical ways are ineffective. Some of non-invasive methods can be expressed as a combination of movement patterns correction, pain management, stretching and strengthening of non-contractile muscles and tissues. In this regard, some studies have reported the positive effect of various conservative techniques on reducing the curvature of kyphosis and improving FHP; but their performance and rate of effectiveness in improving the spinal structure of mentally disabled people is not determined precisely [15]. These studies showed that stretching the shortened muscles, performing the strength exercises and strengthening the weakened muscles in the affected area, cause the recovery of these disorders.

Although the researchers have established some principles to manage the poor physical condition and most of the therapists usually use them, but little studies have been done on the application of these methods on mentally disabled individuals, due to their special condition [16]. The lack of motivation for performing physical activities in this group of people is the most important reason for their postural disorder; and it seems that separating them from healthy people makes them inactive in sports and results to their sedentary life. So, low level of physical activity and immobility in life are declared as the risk factors in mentally disabled people [15].

In the studies on people with mental disabilities, only the effects of physical exercises on the physiological factors of them were examined; and they proved that applied exercises are able to improve the measured factors in mentally handicapped individuals, to some extent. But there are few studies which have been focused on the effect of these activities on stature structure and structural abnormalities of this group [17, 18]. Indeed, the difficulty of intervention development in people with high mental disabilities can be pointed as a possible reason for rare studies on them; because the exercise programs for mentally disabled subjects must completely fit with the characteristics of them in different periods of their life, especially in adulthood, to prepare them for a healthier life in society [19]. As a result, using a purposefully appropriate program in adult mentally disabled men who are also trainable can make them to follow a healthier life, by eliminating their disorders. For this reason, the present study investigated the effect of targeted rehabilitation program with corrective exercises on upper body disorders of mentally disabled adult men who are trainable.

2. Material and Methods

The statistical population of present study were mentally disabled trainable men with IQ of 25- 50, who were living in the disabled care center of Gonbadekavoos. The primary criteria for study entrance were the existence of conditional kyphosis and FHP which are more than 45° and 46°, respectively, in individuals at the age range of 30-45 years. The exclusion criteria for

this study included the presence of any pathological symptoms, the background of fracture, surgery or joint diseases in the spine, shoulder girdle and pelvic, musculoskeletal system disorders, out of normal range BMI, the background for specific treatment methods or physical activities in parallel with research, spinal cord injuries, structural or functional shortness in lower body limbs, use of assistive devices such as brace and taping, neuromuscular disorders and the other anomalies related to the spine such as scoliosis and lumbar. Based on the inclusion and exclusion criteria of the study, all the subjects' physical checkups were performed by an orthopedic specialist who was approved by their care center.

The determination for the minimum number of samples in this study was done by G * POWER sample volume estimation software. Its test power was 0.95, effect size of 0.80 and significance level of 0.05. This software determined 11 subjects as the minimum sample size required for each group in present study. But since 37 disabled men of the center had the eligibility to participate in the research and the parents or supervisors of 28 of them allow their participation, so 16 of these individuals were set as experimental subjects and 12 of them as control subjects, which are more than the necessary minimum sample size. This study was approved by ethics committee of the subject's care center and all the subjects' supervisors presented the informed written consent to the researcher about the participation of their relatives in this study. Fortunately, all the subjects were available to the researcher till the end of rehabilitation program.

2.1. Measuring the kyphosis degree

The kyphosis angle of all subjects was assessed 24 hours before first training session and 24 hours after the last training session. Since the researcher was not able to use radiography in this study, due to the special conditions of the subjects, the Covid 19 pandemic and the non-permission of subject's exit from care center, the variable of kyphosis angle was measured by a spinal mouse. This device is able to assess the curvature of spine, without applying harmful radiation. The different researchers have said that since the spinal mouse is a safe and non-invasive device, it can be considered as a good alternative for radiography, in measuring the thoracic kyphosis angle, and it's optimal validity is reported as (P= 0.001, r= 0.81) [20].

In order to determine the kyphosis angle value in present study, the marking method of spinous processes from T1 to T12 vertebrae was used. Then, by placing the machine's rollers on the upper and lower part of T1 vertebrae, the mouse was pulled down along the spine till the last part of T12 vertebrae. This evaluation was performed in three positions of the subjects; standing upright, trunk's flexion and extension. By moving the mouse on designated vertebrae, the amount of curvature, the shape of spine and the angle of each vertebra, were recorded in all three positions.

2.2. FHP measurement

For measuring FHP, the imaging method with a digital camera (Canon, model: EOS 4000 D) was applied. In order to measure the FHP angle, the subject stands in sagittal view and a photo is taken. Then the angle between seventh cervical vertebra and ear's tragus appendix with horizon line, which was determined by a marker in photo, was measured in 2016 AutoCAD$_{20.1}$ (Figure 1).

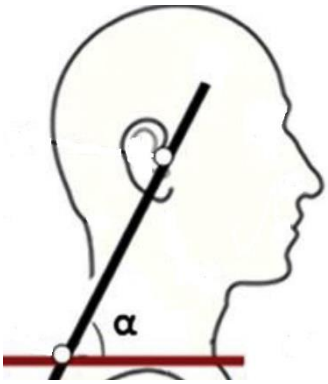

Figure 1. The measurement method of FHP

To reduce the measurement error, the evaluation was repeated for three times and their average was recorded as the main value. The temperature of exercise room for the subjects was provided based on the instructions of American College of Sport Medicine. These places had favorable light, safety and welfare conditions. All measurements and exercises were performed in the care center of the subjects, by maintaining the health protocols [21].

The subjects of control group performed no specific activity during this period and they were only engaged in their daily activities. But the experimental group subjects performed the rehabilitation protocol, including the explained steps below, for two months (three sessions per week, each session 40 to 60 min), under the supervision of researcher and with the help of subject's mentor in care center; the applied protocol aimed to improve the subject's condition of chest spine, head and neck. Due to the special conditions of the subjects and for controlling the correct performance of movement by subjects, each of them practiced by one person, researcher or center's mentor; it means that only two subjects were practiced simultaneously at a time. The training program was done in spring season, May and June, between 9 to 12 o'clock. In order to prepare different parts of upper body and trunk in experimental group subjects, some warm-up movements were performed for 10 min at the beginning of each training session; and the cooling down exercises were also done for 5 min at the end of each training session, by the subjects, for returning to the initial state. The protocol of study consisted of 3 steps, 17 movements in all, that were performed based on the subjects condition and the overload principle. The general steps of exercise execution is presented in Table 1 and the details of movements are available at Figure 2. It should be noted that the subjects welcomed the training protocols.

In order to analyze the information of study, first, the normality of data distribution was checked by Shapiro- Wilk test. Then, the dependent t-test and the independent t-test were applied for within group and between groups' comparisons (experimental with control) of the subjects, respectively. The significance level for evaluating the data was considered at 0.05, test power as 95%, and effect size as 0.7. All the analysis of study was done by $SPSS_{23}$.

Table 1. General steps of rehabilitation exercises protocol

Stage	Set	Repetitions (rs)	Duration: seconds (S)
First stage: Stretching exercises & Chin Tuck	3 sets	3 rs in 1st week to 5 rs in last week	5-20 S each progressive motion till the end of period (Chin Tuck motion: 15 S in first week to 30 S in it's last)
Second stage: Positional & Symmetric movements	3 sets	3 rs in 1st week to 5 rs in last week	5- 20 S each progressive movement till the end of period
Third stage: Strengthening movements	3 sets	3 rs in programs' start to 10 rs at its' end	5 S contraction at the beginning of program to 15 S at its' end

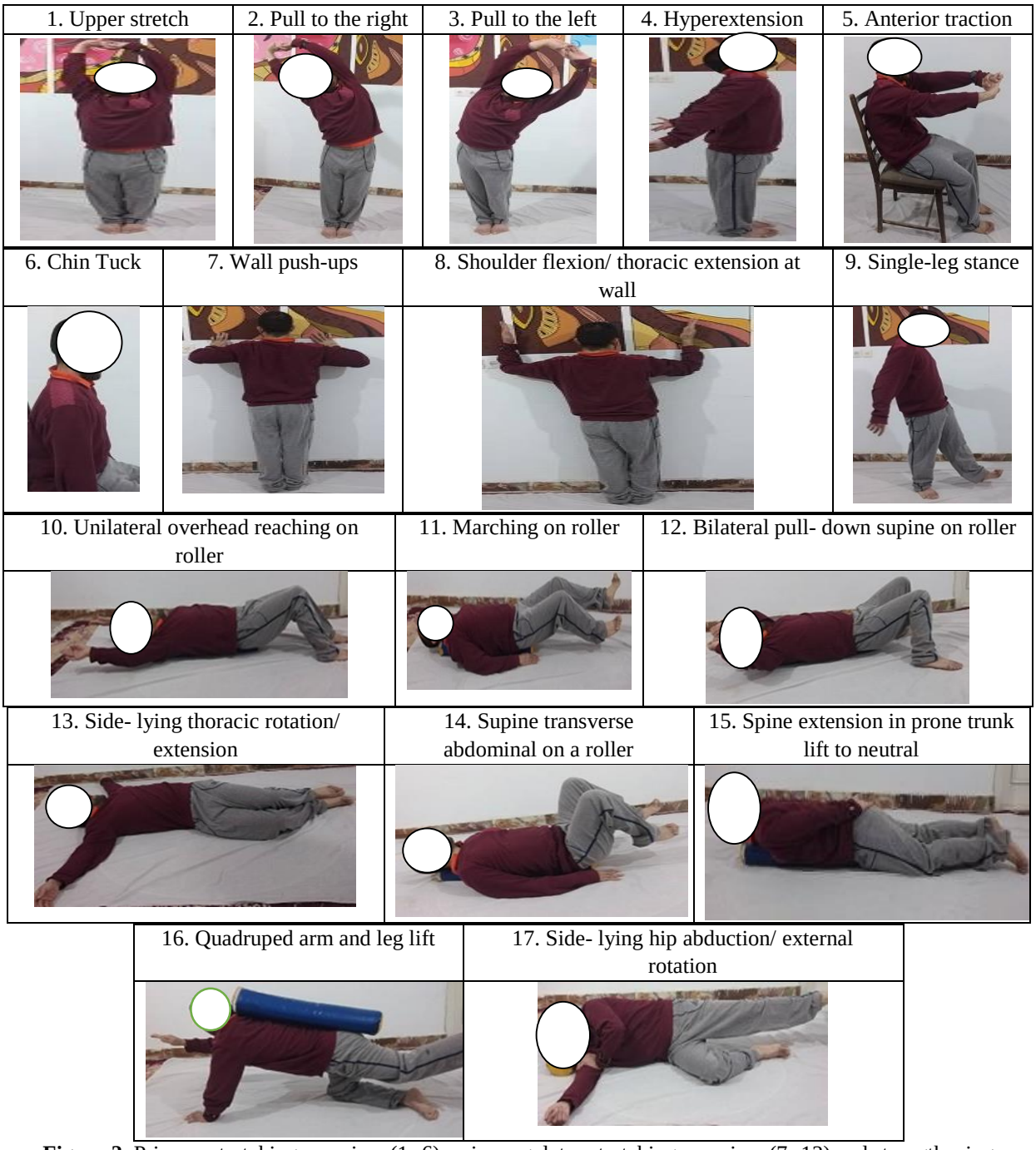

Figure 2. Primary stretching exercises (1- 6), spine regulator stretching exercises (7- 12) and strengthening exercises (13- 17)

3. Results

Table 2 provides the basic demographic information of all study participants. The results of Shapiro-Wilk test in present study showed the normal distribution of variables ($P \geq 0.05$). The results of paired t-test for within group comparison of variables (kyphosis degree and forward head angle) and independent t-test for between groups' comparisons of them are presented in Table 3.

According to the results of paired t- test in Table 3, the mean of kyphosis angle in experimental group presented a significant decrease ($P= 0.008$), but in control group, the kyphosis angle mean showed no

significant change (*P*= 0.101). The mean of forward head angle in experimental group also decreased significantly (*P*= 0.003), but in control group, the mean of this variable had no significant difference (*P*= 0.122). According to the results of independent t-test, the mean of difference for two variables was also significant between control and experimental groups in post-test stage (*P*= 0.001 for both).

Table 2. Demographic information of subjects

Group	Number	Age (year)	Weight (kg)	Height (cm)	BMI (kg/m^2)	IQ
Control	12	36.77 ± 3.33	60.37 ± 13.76	164.85 ± 7.45	22.66 ± 2.11	43.01 ± 4.22
Experimental	16	37.13 ± 5.67	59.19 ± 12.66	165.13± 10.23	22.78 ± 3.03	42.72 ± 3.56

Table 3. The results of dependent and independent t-tests to check the variables' changes (degree of kyphosis and forward head)

Variable	Groups	Test stage	M± SD	Paired t-test	P value	Independent t-test	P value
Kyphosis degree	Experimental	Pre- test	51.26 ± 4.12	- 12.34	* 0.008	- 11.31	* 0.001
		Post- test	49.62 ± 3.56				
	Control	Pre- test	50.88 ± 4.25	0.41	0.101		
		Post- test	51.11 ± 4.34				
Forward head degree	Experimental	Pre- test	48.58 ± 2.14	- 5.53	* 0.003	- 5.45	* 0.001
		Post- test	46.01 ± 3.77				
	Control	Pre- test	49.09 ± 2.07	0.29	0.122		
		Post- test	49.34 ± 4.07				

* Significance level was considered at $P \leq 0.05$.

4. Discussion

The purpose of this study was to check the effect of targeted rehabilitation program with corrective exercises on upper and trunk abnormalities of trainable adult men with mental disabilities; and its results showed a significant decrease in kyphosis and FHP angles of experimental subjects after a period of corrective exercises on head and neck part, as well as the trunk and spine of them. While, no significant change was seen in the participants of control group. In other words, the results of present study showed that purposeful corrective exercises may adjust the side effects of kyphosis and forward head, even in disabled people with severe mental infirmity. The obtained results of this study can support the hypothesis of partial reversibility of postural abnormality changes in the spine.

The number of researches which have been done about the effect of exercises on spine and physical condition of healthy people at different ages are a lot; but a study on investigating the effect of corrective exercises on the spine, head and neck positions of adult men with high mental disability is very rare. So, the researchers had to compare the results of present study with the findings of previous researches on mentally healthy subjects. In this regard, the results of present study are consistent with the findings of Senthil et al. (2017) [22], Feng et al. (2018) [23] and Jang et al. (2019) [24]; but the effectiveness level of rehabilitation with corrective exercises in this study was less than the mentioned ones. For example, Feng et al. reported the reduction in kyphosis angle of their subjects was almost three times more than present study [23]; of course, the reason for such a difference can be attributed to the various types of subjects and the distinct duration of training protocol in two studies. As mentioned before the subjects of present study were mentally disabled adults with very less IQ; and their activity rate, learning level and concepts' transmission are much lower than healthy and younger people, but the subjects of previous studies were healthy and young people such as students [13, 22, 24].

In other study, Bautmans et al. (2010) worked on adult women with osteoporosis, and they used three methods in their research which were stimulation therapy, topping and muscle's corrective exercises [25]. The finding of their study about the reduction level in kyphosis angle was almost the same as present study. The use of both strength and stretching exercise by the subjects of two studies may be the reason of similarity between their results; because these exercises cause more improvement of involved muscles' performance. On the other side, the exercise protocol of the present study which contained strength and stretching activities along with the Chin Tuck workout affected the length of tendons in the trunk, spine and neck muscles of its subjects; and it caused the stability and solidity of ligaments by creating the balance in different skeletal parts. The exercises of protocol's first and second stages, caused an increase in the length of shortened muscles by stretching them and creating flexibility in the subjects; and the exercises of the third stage, resulted to anomaly reduction by increasing the strength and force exerted to the stretched muscles.

The spine regulatory stretching movements as the coordinator of agonist and antagonist muscles and the preliminary stretching exercises of protocol by creating flexibility, caused the increase of muscles' length in the concave and short parts, and increased the strength and power of muscles in convex and stretched side; and the level of anomaly made by kyphosis and FHP in

the subjects of present study decreased with the reduction of their curvature angle [13, 22, 26]. So, designing the accurate program of corrective exercises- including the stretching movements for creating flexibility along with mobility, and strengthening movements of trunk extensor and their regular implement under the direct supervision of researcher- can be pointed as the possible reasons for the effectiveness of corrective exercises in reducing these anomalies. In confirmation with this matter, Itoi and Sinaki (1994), by a study on the role of power in the thoracic kyphosis angle, concluded that the kyphosis angle of people who had a considerable increase in the strength of their dorsal extensors reduced significantly [27].

The researchers also express that performing the strengthening protocol, which is associated with alignment and movability of the spine, can simultaneously cause the reduction of kyphosis in suffering people. Although the strengthening of muscles in the anterior and posterior area of the trunk are very helpful to controll the movements and causing the stability of the spine, but the reinforcement of trunk's deep and stabilizing muscles play crucial role to controll the intervertebral movements and cause the stability of spine in dynamic conditions [27-30]. So, some exercises of present protocol (motion 4 and 5 in strength step) were designed to cause the stability in the spine and to help the movement by stimulating deep muscles; because these muscles allow the trunk and the spine to move automatically and maintain the posture of body in a favorite condition, when the static and the dynamic pressures are applied [28, 29]. Meanwhile, since the chain reactions are the main factors in the optimal effectiveness of corrective exercises, there was more focus on these reactions of the spine in present exercise program; and it also seems that using postural exercises in present study, prevented the deficiency of corrective movements, because the positional and unidimensional performance of corrective programs is a main reason of their inefficiency [29].

The strength imbalance in abductor muscles of the spine and the decrease in the ability of these muscles for producing power, cause improper posture. This reduction of ability also cause the pressure of the upper body's weight force on inactive organs and the increase of length in the abductor muscles of spine, which results to the increase of spinal arches. So, performing the strength and muscle regulating exercises in the second and third stages of present study's protocol, could fortify the situation of muscles in target points and improve the anomaly in suffering people [28, 29].

Biomechanical data also proves the significant correlation of the increase in thorax kyphosis and FHP, with the increase of spinal loads and trunk muscle strength in various positions such as standing situation. These loads can accelerate the destruction process and increase the kyphosis and FHP angles, and finally leads to more disorder and pain of spine especially in neck and chest areas [13, 30, 31]. So, the rehabilitation program of present study (the positional stretching exercises of 2nd stage) was aimed to reduce the biomechanical pressures, especially in the anterior and the concave part of spine, and to establish a bilateral balance on both anterior and posterior sides of the spine. According to the findings of Tarasi et al. (2019), the application of strength and positional exercises is the main reason in effectiveness of exercise for the reduction of kyphosis angle, because these exercises coordinate the agonist and antagonist muscles [32]. It also seems that simultaneous application of positional and combined exercises for this complication in present study made them effective even for the subjects with high mental disabilities [33].

The shortness of posterior neck muscles in people with forward head complication reduces

their ability to have a favorable posture, because these muscles are typically stronger than their antagonist muscles and cause muscle imbalances resulting to adverse posture. It means, weak or stretched muscles in anterior part of the neck cannot protect the proper alignment to have a desired posture [26]. For example, Lynch et al. (2010) showed that the use of stretching exercises in shoulder's anterior muscles and strengthening the posterior muscles of the shoulder, significantly improved the FHP complication in elite swimmers [34]. In people with FHP disorder, the muscles of the deep neck flexors, the neck extensors, the lower trapezius and the rhomboids tend to be underactive, which results to the inability of individual to maintain the upright position of cervical vertebrae. In contrast, the muscles of upper trapezius, levator scapula, sternocleidomastoids and suboccipitals are often overactive in FHP suffering people, but fortunately during present study, by applying symmetrical positional and stretching movements, the hyperactivity of these muscles stopped and the growth of FHP disorder significantly decreased [13].

All in all, the angles of kyphosis and FHP in the mentally disabled subjects of present study had significant improvements, but these amounts were less than the level of recovery in healthy and mostly young individuals of previous studies. So, more studies are still required to find out the level of intervention effect on preventing the growth of these complications in mentally disabled people, because kyphosis and FHP complications happens slowly and increase gradually over the time, and these individuals have lower physical activities and more general weakness than healthy subjects [35]. As the physical activities are more understandable than perceptual and conceptual tasks for the individuals with mental disabilities, it seems that the training protocol of present study was its strength point, because it had combined the positional trainings with the strength ones and used the movability and coordinating exercises for the spine resulted to the significant improvements in the posture of these people [36].

5. Conclusions

The findings of present study proved the correction of upper body disorders such as kyphosis and FHP in trainable mentally disabled people, but the correction of this anomaly, and the prevention of its growth requires more studies. So, the studies are proposed that compare the effects of different methods and evaluate the durability of them in preventing the growth of this kinds of disorders on trainable mentally disabled people. The training protocol of this study provided a condition for its subjects to start the proper activities according to the specisl conditions of them because of their disability, sedentary lifestyle and poor physical condition with structural disorders; so that an improvement in the structure and a reduction in the postural abnormalities of these people happened through increasing the motor function of them.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The author has completely considered ethical issues, including informed consent, plagiarism, data

fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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