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Original Article

The effect of an 8-week Theraband training program with kinesiotaping on the angle of kyphosis in adolescent boys with kyphosis

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Abstract

Background: The necessity and importance of such research, particularly among younger individuals, are quite evident due to the flexibility of bones and the growth of body organs at these ages. By using exercises and a combination of kinesiotaping and Theraband, we can address their deformities and provide them with suitable solutions. The aim of the present study is to investigate the effect of an 8-week Theraband training program with kinesiotaping on the angle of kyphosis in adolescent boys with kyphosis.

Methods: A total of 24 male adolescents from sports clubs in Isfahan (aged 15-18) were selected as a statistical sample. These individuals were selected randomly and through observation. The tool used for measurement was a flexible ruler. Data analysis was conducted using a dependent t-test and covariance analysis.

Results: The pre-test kyphosis angle in the Theraband with kinesiotaping training group was 49.71 ± 0.7 (p = 0.604), and the post-training kyphosis angle was 46.97 ± 0.8 (p = 0.002), indicating a significant reduction.

Conclusions: The results of this study suggest that the combination of Theraband training with kinesiotaping used in this research was effective and met the expected outcomes, resulting in a reduction in the angle of kyphosis in adolescent boys with kyphosis.

Keywords: Spine, Kinesiotaping, Theraband, Kyphosis

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Introduction

The skeletal system refers to the positioning of the musculoskeletal system along the vertical axis of the body during standing, sitting, walking, and other movement activities. Deviations from the ideal postural position are not only aesthetically unappealing but also negatively impact muscle function and may predispose an individual to neurological disorders(1).The spine forms the central axis of the trunk and plays a crucial role in human physiology. In addition to protecting the spinal cord, it plays an essential role in movement. Any injury or deformation can disrupt body function, and as different sections of the spine are interconnected through the vertebral system, changes in one area can affect other areas in a chain reaction. For instance, posterior pelvic tilt can lead to a decrease in lumbar lordosis angle, an increase in thoracic kyphosis angle, and ultimately forward head posture(2). Janda emphasized the interrelationship between the upper quarter and musculoskeletal and nervous systems, noting that any deficiencies or disruptions in any joints or muscles can impact the quality and function of other joints and muscles. In fact, an issue in one area and subsequent changes in joints and muscles in that area can propagate through a chain reaction to other parts of the body, affecting various joints and muscles(3). Generally, chain reactions in the body can be classified into joint, muscular, and nervous categories. It is important to note that these three systems interact with each other, and their function is not independent. Changes in the primary chain may result in issues in the secondary chain, and vice versa(3).

Muscle imbalances arise due to pressures on posture, excess weight, repetitive movements, weakness in deep core muscles, impaired neuromuscular control, inactivity, or incomplete tissue recovery after activity. These imbalances lead to overuse, inappropriate joint pressure, changes in movement patterns, and repetitive microtraumas, resulting in functional disorders and chronic injuries(4-6).

Kyphosis is an abnormal increase in the curvature of the thoracic region. In the case of kyphosis, the pectoral muscles (major and minor), serratus anterior, and latissimus dorsi often become tight and shortened, while the erector spinae, rhomboid, and trapezius muscles become stretched and weakened to maintain balance. According to previous studies, exercises can improve muscle function, spinal alignment, and consequently kyphosis(1). Therefore, this study employs combined exercises to improve the natural alignment of the spine and muscle function.

In this study, two simultaneous methods were considered to improve abnormalities in

adolescents with kyphosis, as each method has certain capabilities that justified their selection. Elastic resistance training encompasses various training methods, from strength to flexibility to speed and agility. Elastic resistance is also useful for stabilizing exercises that target core muscles through whole-body exercises. Rehabilitation professionals use these exercises to help patients regain strength after injury(7). Another intervention used to correct muscle imbalance is kinesiotaping. Due to its specific texture and adhesive properties, kinesiotaping creates minimal skin contact, allows ventilation, and reduces the risk of skin damage during the intervention(8).

There are two theories regarding muscle strength enhancement when using kinesiotaping. First, applying kinesiotape on the muscle increases muscle tone. Second, it enhances proprioception and sensitivity to force through muscle receptors(9). Kinesiotaping enhances proprioceptive function through continuous stimulation of superficial skin receptors, improving the efficiency of surface tissues by normalizing muscle tension, reducing muscle fatigue, creating more space for improved blood flow and lymphatic fluid, limiting space for excess fluid and subcutaneous bleeding, correcting muscle function by increasing weak muscle strength, and reducing pain through neurological mechanisms(9). For example, Meissner's corpuscles located just beneath the skin's surface are sensitive to touch, while Pacinian corpuscles located subcutaneously are sensitive to pressure. Tactile and pressure stimulation by kinesiotaping activates these two receptors, which reduce pain through descending inhibitory pathways and the gate control theory of spinal modulation(8). Moreover, kinesiotaping, by increasing the space between the skin and contracting tissue, aids in enhancing lymphatic flow. In addition to its effect on proprioception, kinesiotaping may also impact muscle strength. Kinesiotaping, through increased skin stimulation, leads to an increase in muscle strength(10).

In previous studies, factors such as the insufficient duration of the training program, lack of variety in corrective exercises, failure to integrate stretching exercises with strengthening exercises, and lack of supervision of the corrective training program have been reported. Additionally, most past research focused on planning localized corrective exercises, which may lead to less effective results than expected. As the use of combined exercises can have a greater impact on improving and correcting abnormalities and can lead to better and more efficient methods, these exercises can be considered a suitable alternative for correcting abnormalities. Therefore, the aim of the present study is to investigate the

effect of an 8-week Theraband training program with kinesiotaping on the angle of kyphosis in adolescent boys with kyphosis. Given the aforementioned points, the researcher's hypotheses in the present study are as follows: Does the Theraband with kinesiotaping training method improve the kyphosis angle in male students? The results of this study can not only be used in the rehabilitation and treatment of individuals with kyphosis but also can be recommended as preventive and deterrent interventions for pain and abnormalities.

Materials and methods

This study is a quasi-experimental design with a pre-test and post-test approach. The study population consists of 24 adolescent boys with kyphosis. The sample size was confirmed using previous studies, and the sample size is supported by the literature(11). The study's samples were purposefully selected from high school students in Isfahan aged 15-18 years. A flexible ruler was used to measure the kyphosis angle, and the subjects were randomly divided (by drawing lots) into two groups. The control group (age: 16.67 ± 0.6 years; height: 159.6 ± 9.6 cm; weight: 61.27 ± 11.6 kg; BMI: 24.88 ± 2.07) and the kinesiotaping with Theraband group (age: 16.39 ± 0.4 years; height: 160.1 ± 0.85 cm; weight: 62.13 ± 8.41 kg; BMI: 26.24 ± 1.83) voluntarily participated in the study.

In this study, the inclusion criteria for participants required that all individuals had a kyphosis angle greater than 42 degrees(12). Additionally, they should have no history of mental illness, fractures, surgery, spinal joint diseases, or any pain in the neck or upper extremities. For the initial selection of participants, verbal confirmation was obtained through interviews about their level of activity and willingness to participate in the study before the consent form and individual information forms were provided to them. Subsequently, participants who expressed interest in joining the study were given an explanation of the study's aims and benefits, and a written consent form and personal information questionnaire were provided. Once completed, the forms were collected. Initially, all participants were familiarized with the research design, training protocols, and measurement methods. General information and individual characteristics were recorded using the relevant questionnaire, and the participants' weight and height were measured. If a participant missed two sessions of the interventional exercises, they were excluded from the study. Participation in exercise and corrective training, or any occurrence of fractures or neuromuscular problems during the study, also led to the exclusion of the sample from the study.

The process of measuring the angle of kyphosis:

In the pre-test phase, a flexible ruler was used to measure the kyphosis angle of the subjects. This instrument has an accuracy of one-tenth of a degree and a reliability coefficient of 97% (12). The subjects stood without upper body clothing, and the process of measuring the kyphosis angle was as follows: the spinous processes of the second (T2) and twelfth (T12) thoracic vertebrae were identified as the starting and ending points of the curve, respectively, using landmarks (red circles with a diameter of one centimeter that could be removed from the skin). To avoid measurement errors related to skin movement, the examiner kept their finger on the prominence while the subject was in a standing position and then marked the desired area. The subjects stood barefoot, with about 15 centimeters between their feet. They had to stand in a position where their head was in a natural position, looking forward, with their weight evenly distributed between both feet. The flexible ruler was placed between the second and twelfth thoracic vertebrae on the spinous processes of the subjects to take the shape of the thoracic spinal curve. Then, without altering the ruler's position, it was placed on white paper, and the curve shape was drawn. The distance between the two points (length) L and the depth of the curve (width) H were measured using a ruler, and the kyphosis angle ϴ was calculated using the trigonometric formula. To prevent measurement errors of the thoracic spinal curvature angle, the measurement was repeated three times, and the average of the three repetitions was recorded as the kyphosis angle of each subject's thoracic spine. The formula used was: $\theta = 4\text{Arctan}(2H / L)$ (13).

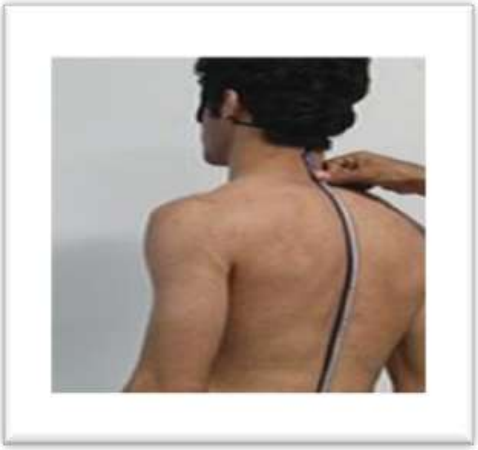

Figure 1: Measuring a flexible ruler

Intervention program for the combined group (Kinesio tape and theraband)

Theraband exercise program

The Theraband exercise program was implemented over 8 weeks, with sessions three times a week, lasting between 40 to 55 minutes each (the duration of the exercises increased progressively throughout the program). Warm-up exercises were performed for 5 to 10 minutes while maintaining balance. The participants then engaged in training goals for 30 to 35 minutes using the designated resistance bands, transitioning from easy to difficult exercises and from light to heavy resistance, in three different forms: standing, sitting, and with loops and metal clips attached to wall columns at varying angles, both in front and behind (with the back against the wall). These exercises included stretching of the pectoral muscles and strengthening of the back muscles. The training was individually tailored and closely supervised by the instructor, and cooling down exercises were performed for 5 to 10 minutes at the end. This section also includes the Theraband exercise protocol combined with kinesiotaping.

The Theraband exercise program, combined with kinesiotaping, was implemented in this study. The duration of Theraband exercises ranged from 40 to 55 minutes, which were divided as follows:

Section 1:

5 to 10 minutes of general stretching exercises and light aerobic activities to warm up the test subjects.

Section 2:

30 to 35 minutes of strengthening exercises targeting the back muscles.

Section 3:

5 to 10 minutes of stretching exercises and gentle walking to cool down the test subjects.

Table 1: Summary of TheraBand Exercises Implemented in the Study

Week	Training Goals	Type of Exercise	Number-Repetition	Rest Time	Performance and Exercise Execution
1	Familiarization with band and how to use it	Stretching 1 Strengthening	2 sets, 6-10 reps	30 seconds	Seated rowing exercise
2	1- Stretching pectoral muscles 2- Strengthening middle trapezius and rhomboid muscles	Stretching 2 Strengthening 1	2 sets, 6-10 reps	30 seconds	1- High rowing with hip bending 2- Seated rowing with iron ring attached to the wall
3	1- Stretching pectoral muscles	Stretching 2	3 sets, 6-	25	1- Elbow extension with iron ring

Week	Training Goals	Type of Exercise	Number-Repetition	Rest Time	Performance and Exercise Execution
	2- Strengthening middle and lower trapezius and rhomboid muscles	Strengthening 1	10 reps	seconds	attached to the wall 2- Dynamic elbow extension with iron ring attached to the wall
4	1- Stretching intercostal and pectoral muscles 2- Strengthening middle and lower trapezius muscles	Stretching 2 Strengthening 2	3 sets, 10-8 reps	25 seconds	1- Shrugging shoulders and reverse butterfly 2- Dynamic shrugging shoulders and reverse butterfly with iron ring attached to the wall
5	1- Stretching pectoral and intercostal muscles 2- Strengthening lower trapezius and spinal erector muscles	Stretching 3 Strengthening 2	4 sets, 10-8 reps	20 seconds	1- Rowing at shoulder level 2- Rowing at shoulder level with iron ring attached to the wall
6	1- Stretching pectoral and intercostal muscles 2- Strengthening upper trapezius, deltoid, and spinal erector muscles	Stretching 4 Strengthening 3	4 sets, 15-10 reps	20 seconds	1- Opening arms to the sides, bringing shoulder blades back 2- High rowing exercise
7	1- Stretching pectoral, intercostal muscles 2- Strengthening upper trapezius, rhomboid, and spinal erector muscles	Stretching 5 Strengthening 4	5 sets, 15-10 reps	15 seconds	1- Overhead press exercise 2- Dynamic overhead press exercise
8	1- Stretching pectoral and intercostal muscles 2- Strengthening back, lower trapezius, and rhomboid muscles	Stretching 5 Strengthening 4	6 sets, 15-10 reps	15 seconds	1- Diagonal arm movements 2- Lat pulldown exercise

The Kinesiotaping Section

Applying Kinesiotape on the spine increases muscle strength and endurance due to the nervous system's response to additional load coupled with increased muscular activity. This period sees an increase in the activation of motor units and the sequencing of muscle activities following the use of TheraBand exercises. Additionally, the facilitation of muscle stretching by Kinesiotape cannot be overlooked. In this study, as mentioned earlier, this intervention was combined with TheraBand exercises, during which the back muscles were taped. The landmarks (T2 and T12) were identified, and the tape was applied symmetrically and parallel to both sides of the lumbar region, 5 cm above T2 and 5 cm below T12(14). The Kinesiotaping program was implemented for 8 weeks, three times per week. Given that the

goal of this study was to facilitate the activity of the erector spinae muscles, the ligament-tendon taping method was employed. The start of the tape was applied without tension 5 cm above T2, followed by stretching the tape to 50% tension and attaching the end without tension 5 cm below T12. The shape of the Kinesiotape in this method resembled an "I" shape.

Statistical Analysis

Data analysis was performed using statistical methods at both descriptive and inferential levels. For kyphosis changes, descriptive statistics such as mean and standard deviation were used. For inferential statistics, changes within and between groups were compared using covariance analysis in both groups. Data analysis was carried out using SPSS software version 25, with a significance level set at $P < 0.05$.

Table 2: Physical and Physiological Characteristics of Participants

Group	Sample Size	Age (years)	Height (meters)	Weight (kilograms)	BMI (kg/m²)
Combined Group	12	16.39 ± 0.40	1.60 ± 0.85	62.13 ± 8.41	24.26 ± 1.83
Control Group	12	16.67 ± 0.60	1.59 ± 0.69	61.27 ± 11.06	24.88 ± 2.07

Table 3: Descriptive Data Changes

Variable	Group	Pre-Test	Post-Test
Kyphosis Angle	Combined Group	49.71 ± 0.7	46.97 ± 0.8
	Control Group	48.5 ± 4.0	48.4 ± 2.0

In Table 3, the changes in kyphosis angle in both pre-test and post-test phases are presented. According to this table, the changes in kyphosis angle after both types of intervention are significant.

Results

The statistical analysis of covariance revealed a significant difference in the kyphosis angle in the Kinesiotaping and Theraband group ($p = 0.002$, $F = 2791.841$) (Table 4).

Table 4: Results of ANCOVA on the mean kyphosis angle post-test in the Kinesiotaping and Theraband group and the control group with pre-test control

Variable	Source of Variance	Sum of Squares	df	Mean Squares	F	Significance Level	Eta Squared
Kyphosis Angle (mm)	Pre-test	0.078	1	0.078	0.793	0.381	0.029
	Group	272.209	3	272.209	2791.841	0.002	0.990
	Error	6.266	33	0.99			
	Total	166184.6	36				

As shown in Table 4, after controlling for the pre-test, there is a significant difference in the kyphosis angle between the experimental and control groups ($p = 0.002$, $F = 2791.841$). The effect size, or difference, is equal to 0.99, indicating that 99% of individual differences in kyphosis are due to the impact of the eight-week intervention with the Kinesiotaping and Theraband group. The statistical power is equal to one; therefore, it is concluded that eight weeks of the Kinesiotaping and Theraband training program has a significant impact on the kyphosis angle of boys aged 15 to 18 years.

Discussion

The primary goal of this study was to investigate the impact of an 8-week combined training program involving Theraband and Kinesiotaping on the kyphosis angle of adolescent boys with kyphosis. The study results demonstrated that the combined training program could improve the kyphosis angle in the participants. A comparison of pre-test and post-test results within the intervention group revealed that Theraband and Kinesiotaping exercises significantly altered the kyphosis angle. Additionally, the intervention group experienced improvements in the alignment of the thoracic spine compared to the control group. This study was conducted to address one of the common postural issues and to slow its progression while providing a favorable context for further treatment effects. The combined training approach was employed in this study because previous studies primarily focused on corrective exercises alone, which did not provide reliable or comprehensive evidence regarding the efficacy of such exercises on postural abnormalities of the spine. Previous research reported that the reasons for these shortcomings included insufficient duration of the training program, inadequate variety in corrective exercises, the absence of combining

stretching and strengthening exercises, and a lack of supervision in corrective training programs. Thus, this study utilized a combined training method of Theraband and Kinesiotaping to address kyphosis in adolescents with kyphosis, as each of these methods offers unique capabilities, which was the reason for their selection.

Based on the research findings, it can be stated that theraband exercises with kinesiotape are effective in reducing kyphosis angle in boys with kyphosis. Elastic resistance training has gained popularity in individual training for improving readiness and enhancing athletic performance. Elastic resistance is mainly performed using long bands or tubes and provides a variety of applications and exercises due to its nature. By using a single piece of tubing or band, all major muscle groups in the body can be strengthened. Elastic resistance training encompasses various training methods, from strength to flexibility to speed and agility improvement. Resistance training with elastic bands is a cost-effective, convenient, and efficient form of resistance training recommended for each training session. Research has shown that all professional athletes and even sedentary individuals in any age group can benefit from resistance training with elastic bands. Training with elastic resistance contains a simple secret. As an elastic band is stretched, its resistance increases, providing an increasing stimulus for muscle strength and engaging one or more joints at a time, making movements more effective and practical(7) . This process is very important and sensitive in the realm of corrective movements. In strength training, therabands, with their elastic resistance, possess different characteristics compared to free weights, including the fact that therabands do not rely on gravity to generate resistance. Therefore, various speed and movement patterns can be practiced using this equipment. Additionally, given that resistance training with bands has a strength-focused nature, this resistance, through the elastic force generated by the band, can have a strengthening effect on the back muscles(7). Iliepu and colleagues (2022) conducted a study examining the effect of a comprehensive corrective exercise program on kyphosis angle and balance in adolescents with kyphosis, which revealed that combining proprioception with corrective exercise programs for kyphosis provides a comprehensive approach that can increase the effectiveness of the intervention(15). Park and colleagues (2020) investigated the effect of a combination exercise program on spinal curvature and balance ability in adolescents with kyphosis and found that a combined intervention program was effective in improving spinal curvature and balance in adolescents with postural kyphosis(16). Al-Tawab and colleagues (2021) studied the efficacy of theraband versus general active exercise in improving postural kyphosis and found that

theraband was more effective than general active exercise in reducing postural kyphosis and alleviating back pain in adult women. However, theraband was more effective in reducing mean intervention post-treatment across both active exercise groups(7). Moreover, the research findings suggest that kinesiotape also plays a significant role in improving kyphosis angle. Kawas and colleagues (2019) investigated whether kinesiotape helps reduce kyphosis angle in adolescents with kyphosis. They studied 50 students and found that kinesiotaping improved kyphosis, aligning with the current research(17). Kim Ja and colleagues (2018) studied the effect of kinesiotaping on forward head posture before and immediately after use. They examined the impact of kinesiotape on forward head posture in 18 adolescent students and found that kinesiotaping was effective in improving forward head posture, consistent with the present study(18). Ji Kang and colleagues (2019) examined the impact of two types of taping techniques, with and without stretching exercises, on 30 individuals with shoulder impingement syndrome and found that taping techniques, with and without stretching exercises, were effective in treating shoulder impingement syndrome(19).

Active exercise therapy has multiple local and systemic effects on various aspects of the body's structure and function. These effects encompass a wide range of changes from the cellular level to broader systemic or even individual and societal levels. In addition to improvements such as increased flexibility and muscle strength, improvements in proprioception, which are typically the first and most immediate effects noted by the treatment team, should also be accompanied by attention to broader effects such as posture and energy consumption. In other words, the impact of exercise therapy on the energy consumption required for patient movement and mobility should be regarded as one of the most prominent manifestations of movement efficiency and sufficiency, meriting research focus. Hence, any research activity aimed at evaluating the impacts of active therapeutic exercises or combining these movements with specific treatment methods such as kinesiotaping or theraband can lead to improvements in adolescents with kyphosis. This, in turn, can provide information for the development, modification, and enhancement of treatment methods to achieve standardized, active, and non-invasive protocols for specialists. By offering corrective exercises, practitioners can help prevent and correct physical abnormalities. As human advancement progresses and his ability to utilize tools increases, his mobility has become considerably limited. Inactivity or lack of exercise is recognized as one of the major issues facing modern humans. (20).

The therapeutic effects of kinesiotaping in correcting soft tissue disorders can be explained through various mechanisms, all of which are essentially due to the influence of this intervention on mechanoreceptors. These include**: Mechanical Correction**: Kinesiotaping stabilizes soft tissues and joints, enabling the activation of mechanoreceptors and producing desirable therapeutic effects.**Volume Correction**: By applying pressure and preventing an increase in soft tissue volume, kinesiotaping helps reduce pain and inflammation.**Functional Correction**: By stimulating mechanoreceptors and other skin receptors around a joint during active movements, kinesiotaping aids in controlling joint movements.**Fascial Alignment Correction**: The elastic properties of kinesiotape help align fascia in an appropriate orientation.**Lymphatic Flow Correction:** Soft tissue correction through previous mechanisms generally reduces pressure on lymphatic vessels and aids lymphatic circulation (13). Some studies have indicated that kinesiotaping from the origin to the insertion of a muscle at 50-75% tension relative to the initial length facilitates muscle function, while kinesiotaping from the insertion to the origin of a muscle at 15-25% tension relative to the initial length inhibits muscle function. The percentage of tension used in studies requires more precise specification. The method of reporting tension percentages varies across different studies. For instance, Kinesio Tex tape connects to its backing paper with about 25% tension, which is considered "Tension Off Paper." Once separated from the backing, the length of the tape is reduced, which is the resting length of the tape with zero tension. Therefore, different methods and terminologies used to describe the level of tension make understanding the actual tension challenging for readers, complicating the comparison of studies with each other (21, 17).

Among the limitations of this study are the small sample size and the fact that all participants were from the same city. Additionally, the lack of control over psychological and emotional factors may have impacted the outcomes. Therefore, future studies should investigate the effects of these exercises with different protocols, durations, and frequencies on different populations to better understand the impact of combining corrective exercises with other therapeutic interventions.

Conclusion

The findings of this study demonstrated that utilizing novel combined methods such as theraband with kinesiotape three days a week for eight consecutive weeks positively

impacted the improvement of kyphosis in the subjects. Therefore, it is recommended that future studies incorporate motor and functional control in addition to the prescribed exercises in this research into the exercise program. Stretching shortened muscles along with strengthening weak muscles had a notable and significant impact on the kyphosis angle of adolescents with kyphosis. These exercises were beneficial for achieving physical and mental health benefits and improving performance. The diverse nature of theraband exercises increases motivation for individuals to perform the exercises, which could be one of the reasons for the effectiveness of these exercises. In conclusion, the combined exercise program of theraband with kinesiotape in this study was effective and met expectations.

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