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ORIGINAL ARTICLE

The Functional Correction of Forward Shoulder Posture with Kinesiotape Improves Chest Mobility and Inspiratory Muscle Strength: A Randomized Controlled Trial

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ABSTRACT

Background. Kinesiotape (K-tape) application can attenuate postural malalignment. However, the effects of K-tape on the changes in the respiratory system in postural problems remain unclear. **Objectives.** This study investigated the effects of 6-week functional correction with the K-tape on the forward shoulder posture (FSP) and respiratory function. **Methods.** A randomized clinical trial was performed in the study. Thirty-one young female volunteers with FSP, aged 18 to 25, were randomly divided into control (n = 16) and intervention groups, the latter receiving two parts of 50% tension K-tape for each side of the shoulder for six weeks to decrease posture misalignment (n = 15). Then, the participants were subjected to an evaluation of the pectoral muscle length using a vernier caliper, chest expansion using a measuring tape, and respiratory muscle strength using a respiratory pressure meter. A two-way ANOVA was used to compare the differences within and between the two groups. **Results.** After six weeks of intervention, the K-tape group showed significant improvement in shoulder alignment (p = 0.001) and an increase in pectoralis minor index (PMI) (p = 0.019) compared to baseline and those in the control group. The magnitude of the chest expansion meant higher mobility (p < 0.001) and maximal inspiratory pressure (MIP) (p = 0.026) in the K-tape group compared to baseline. **Conclusion.** The 6-week postural K-taping can improve the PMI and attenuate the FSP, with the effects remaining for two weeks. Furthermore, correcting shoulder posture with the 50% tension K-tape can enhance the malaligned shoulder's chest expansion and inspiratory muscle strength.

KEYWORDS: ***Kinesiotape, Functional Correction, Postural Malalignment, Respiratory Muscle, Thoracic Cage.***

INTRODUCTION

Poor posture is biomechanically inefficient and can lead to several health problems. It harms sports performance and endurance, mood stabilization, and respiration. Both active and sedentary people nowadays are influenced by daily lifestyles that cause them to adopt improper postural alignment, especially forward shoulder posture (FSP), which results in musculoskeletal problems (1). The FSP is generally found among office workers, students, and overhead athletes who assume poor postures for a long time, causing upper extremity muscle imbalance (2, 3). It leads to musculoskeletal problems that cause shoulder and scapular mobility impairment, such

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as shoulder impingement and non-specific arm pain (4, 5).

Several studies have found that females are more than 1–3 times more likely than males to experience musculoskeletal problems due to abnormal working postures (6, 7). A higher prevalence of musculoskeletal problems has been observed in females than males due to anthropometric differences and work-related musculoskeletal disorders (8, 9). These findings suggest that suffering from musculoskeletal disorders can lead to limited physical activities and a diminished quality of life (10). Moreover, people suffering from such disorders may lose their income as they spend more on medical treatment, affecting the country's economic system (11).

Moreover, FSP harms the musculoskeletal system and affects chest wall mobility and respiratory function (12). According to Ghanbari et al.'s (2008) study, the decrease in lung capacity in females was related to a higher degree of FSP (13). Therefore, the FSP affects the musculoskeletal system and causes problems with the respiratory system among athletes and sedentary individuals.

Currently, functional correction, usually in the form of exercise programs or shoulder supports and braces, is adopted to reduce FSP (14, 15, 16). However, these techniques cannot be used in some particular conditions, such as in the initial post-operative period and with limited shoulder mobility (17). As a result, the efficacy of shoulder mobility declines. Elastic therapeutic tape, also known as kinesiotape (K-tape), was developed by Kase in 1976 to correct muscular imbalances and facilitate joint proprioception (18, 19, 20). It is one of the techniques currently used to help athletes achieve peak performance, activate motor relearning, and correct the shoulder posture and hemiplegic shoulder pain of patients who cannot actively exercise (21, 22).

Previous studies have reported successful K-tape postural correction. Han et al. (2005) showed an immediate effect when using K-tape to facilitate the shoulder proprioception of participants with FSP (23). With this technique, muscular movement around a joint, the forward posture of the shoulder, and the scapular distance were improved. Werasirirat et al. (2018) attempted to modify the functional correction technique using 4-week K-tapping for FSP reduction (24). Besides tapping attachments between the thoracic vertebrae and the acromion process of the scapular, pectoralis minor muscle stretching with K-tape further provided beneficial effects for FSP reduction (25).

However, studies have also indicated that using K-tape to reduce FSP could alter the respiratory functions such as respiratory muscle strength or rib cage mobility. Therefore, the present study aims to investigate the long-term impact of the functional correction technique using K-tape for six weeks and monitor the continued effect on FSP, respiratory muscle strength, and chest expansion two weeks after intervention.

MATERIALS AND METHODS

Research Methods. A single-blind randomized controlled trial was conducted in the current study. An investigator used a computer-generated simple allocation. After the participants gave informed consent, a two-arm, randomized controlled trial compared the 6-week intervention of receiving functional correction using K-tape, as in a previous study (26). Meanwhile, the control group received no intervention and was educated in FSP management afterward. Participants in the intervention group underwent K-tape correction of both shoulders with a tension of 50% (16).

Research Participants. This study was registered at the Thai Clinical Trial Registry (TCTR20200702001). The study population included participants aged 18–25 who had undergone FSP evaluation and were recruited through social media. The inclusion criteria were healthy participants with FSP, a normal body mass index (BMI), and no underlying diseases. The FSP was defined as the distance from the anterior tip of the acromion process to the examination table being greater than 2.54 cm, or 1 inch (27). The exclusion criteria were participants with skin allergies to elastic tape, a smoking habit, a history of chronic neck or shoulder pain with a pain scale of more than three, cardiopulmonary problems, an exercise frequency of more than two times per week, and those who denied participation.

The sample size followed the study by Balbás-Álvarez et al. (2018) and used the G-power program version 3.1.9.2 (Heinrich Heine University Dusseldorf, Dusseldorf, Germany) (28). An ANOVA with repeated measures and interaction within-between factors was calculated with a statistical power of 0.9, an α error probability of 0.05, and an effect size of 0.3. The eligible participants (n = 32) were randomly allocated into two groups, i.e., the control (n = 16) and intervention groups (n = 16). The calculated sample size was 13 participants per group. However, three more participants were added to each group due to a 20% dropout rate. During the experimental period, only one participant in the intervention group could not complete six weeks due to allergic reactions; therefore, 15 participants in the intervention group were analyzed (Figure 1).

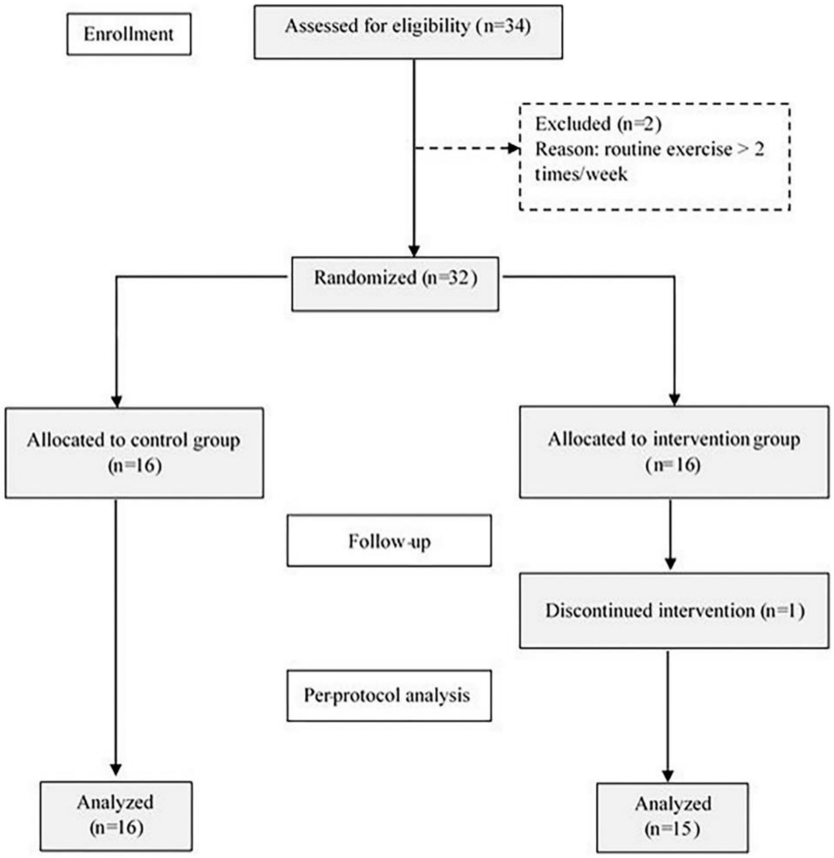

Figure 1. Consort statement flow chart.

Taping Protocol. The classic series of K-tape (Kinesio tape®, Marathon Inc., Bangkok, Thailand) used in this study was made of natural cotton with elastic fiber and medical acrylic adhesive. The K-tapes were applied and replaced with new ones every two days for six weeks (29). Two parts of the K-tape were employed for each side of the shoulder and stretched with 50% tension of its original length by a certified physical therapist who had experience using it (Course code: KAS-441-010718-01-US). Before applying the K-tape, a participant relaxed in a standing position and was asked to remove their shirt. To achieve the desired shoulder position, a functional correction was actively performed by scapular retraction, and the shoulders were held in retraction for some time. The K-tape was first applied with 50% tension from the anterior aspect of the acromion process of the scapular to the spinous process of the fourth thoracic vertebra (T4). Then, the K-tape was applied with 50% tension from the same origin to the insertion at the spinous process of the tenth thoracic vertebra (T10) in the invention group. The tape was not applied to the control group (Figure 2). After the experimental taping was applied to both shoulders, the participant rested in a relaxed position. If a participant experienced skin irritation, the tape was immediately removed and was followed by cleaning or bathing (30, 31).

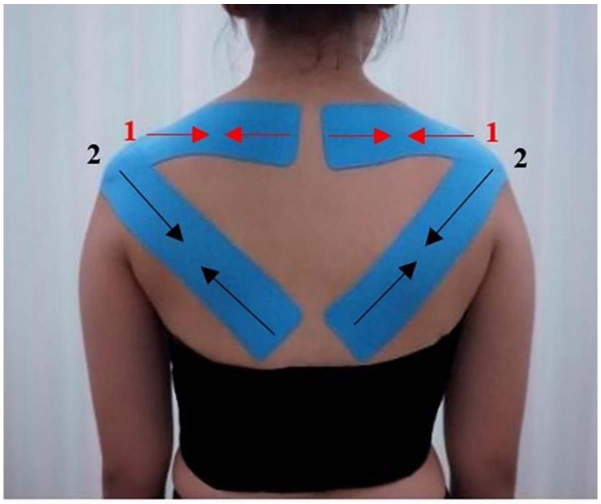

Figure 2. Application of the first and second Kinesiotape with 50% tension to both shoulders.

Measurement of Research Variables. In terms of quality control, all measuring devices were reliably calibrated by experienced technicians before the experiment was started. In all outcome measures, the interrater reliability of an examiner was tested in a preliminary study. The same investigator accomplished each testing procedure. In this study, all parameters showed ICC (1, 3) value in the 0.80–0.99, which was considered very good reliability ($p < 0.001$).

The outcome measures were evaluated immediately after the 6-week intervention period and two weeks after completing the intervention (follow-up). These measures included the magnitude of FSP, the pectoralis minor index (PMI), the amplitude of chest expansion, the maximum inspiratory pressure (MIP), and the maximum expiratory pressure (MEP). The same investigator, blind to the randomization, performed all measurements before and after the K-tape application.

The magnitude of FSP was assessed using a vernier height gauge (Mitutoyo 506-207, Japan) with a 0–200 mm range, 0.02 mm resolution, and 0.03 mm accuracy. Each participant was palpated and marked at the anterior tip of the acromion process on the scapular. In a supine position, the measurement of the distance from the examination bed to the anterior aspect of the subject's acromion process indicated the magnitude of FSP in centimeters (27).

The PMI was calculated from the pectoralis minor length and normalized with the subject's height in centimeters. The left and right pectoralis minor lengths were measured using a vernier caliper (530-101 series, Mitutoyo, Japan) with a 0–150 mm range and 0.05 mm accuracy. In a relaxed sitting position, markings were made on the inferior angle of the coracoid process and the fourth costosternal on both the left and right sides (32).

The chest expansion was determined from the amplitude of the thoracic wall circumference during full expiration and inspiration. The participants sat on a chair without back support, placed their feet on the floor, flexed their elbows, and put their hands on their waists. Three levels of chest wall circumference, upper, middle, and lower chest, were determined using apparent landmarks on the subject's skin. The fifth thoracic spinous process (T5) and the third intercostal space at the mid-clavicular line were marked for the upper chest area. The seventh thoracic spinous process (T7) and the fifth intercostal space at the mid-clavicular line were marked for the middle chest area. The tenth thoracic spinous process (T10) and the tip of the xiphoid process were measured for the lower chest area. A measuring tape was fitted around each landmark to measure each level of chest expansion in centimeters (33). Each participant was verbally instructed to exhale and then inhale fully. The differences in the chest wall circumferences between full expiration and inspiration were recorded.

The respiratory muscle strength was determined by measuring the MIP and MEP in centimeter water pressure (cmH_2O). The evaluation followed the American Thoracic Society / European Respiratory Society (ATS/ESR) protocols (34). A respiratory pressure meter (Micro RMA, Micro

Medical Ltd., England) was used to record the pressure at the mouth during maximal inspiration and expiration. The participants were generally assessed in the sitting position with an applied nose clip. The MIP was recorded during the maximal inspired maneuver from the residual volume, whereas the MEP was noted during the Valsalva maneuver of the maximal expiration from the total lung capacity. The measurement was performed for at least three maneuvers, with a 5–10% reproducibility range.

Data Analysis. The results were expressed as mean ± SEM and analyzed by the Statistical Package for Social Science for Windows (SPSS 26). The Shapiro-Wilk test was used to test for a normal distribution. At baseline, an independent T-test was used to compare the characteristics of the participants in the control and intervention groups. Two-way ANOVA and Bonferroni post hoc tests were performed to compare the differences within and between the two groups. The level of significance for the statistical test was $p < 0.05$.

Research Ethics. The Ethics Committee approved the trial protocol of Srinakharinwirot University (SWUEC 222/2562). The study was conducted per the principles of the Declaration of Helsinki.

RESULTS

The baseline characteristics of all participants are shown in Table 1. There were no significant differences in age, BMI, or outcome measures, including FSP, PMI, MIP, MEP, and chest expansion, between the control and intervention groups. The interaction between time and intervention was demonstrated by the magnitude of FSP and chest expansion in all parts ($p < 0.05$). The baseline comparison between the control and the intervention groups immediately after the six weeks of the intervention and two weeks after the intervention is shown in Table 2. Compared to baseline, the magnitude of FSP was lower in the intervention group, and this lower value remained two weeks after the intervention.

Moreover, the intervention group's PMI was significantly higher than the control and baseline. Compared to the control group, the PMI was significantly higher two weeks after the intervention group's intervention. Considering the three parts of chest expansion, the intervention group markedly improved chest expansion after the six weeks of intervention, and the increment was also found two weeks after the intervention, especially in the upper part. Moreover, the inspiratory muscle strength, as measured by the MIP, was significantly increased after the six weeks of intervention, and this value was retained two weeks after the intervention. On the other hand, the expiratory muscle strength, as measured by the MEP, revealed no significant difference.

Table 1. Baseline characteristics of participants in the control and intervention group (Mean ± SEM)

Characteristics	Control group (n=16)	Intervention group (n=15)	*p*-value
Age (year)	20.38 ± 1.25	20.00 ± 0.32	0.160
Body mass index (kg/m^2)	20.47 ± 0.64	20.07 ± 0.36	0.600
Dominant hand (right:left)	16:0	15:0	-
Forward shoulder posture; FSP (cm)	4.53 ± 0.72	5.32 ± 0.38	0.144
Pectoralis minor index; PMI	9.18 ± 0.4	9.55 ± 0.19	0.157
Maximum inspiratory pressure; MIP (cmH$_2$O)	51.00 ± 19.54	52.13 ± 5.84	0.797
Maximum expiratory pressure; MEP (cmH$_2$O)	59.93 ± 22.88	63.93 ± 4.95	0.837
Upper chest expansion (cm)	6.54 ± 1.02	6.61 ± 0.19	0.857
Middle chest expansion (cm)	5.98 ± 1.33	5.57 ± 0.21	0.420
Lower chest expansion (cm)	6.72 ± 1.16	6.69 ± 0.2	0.683

DISCUSSION

The present study is the first to illustrate how K-tape applied with a functional correction technique over six weeks could improve FSP and increase PMI. Moreover, this improvement could also stimulate the upper, middle, and lower chest expansion, thus, recovering and strengthening the related respiratory, muscular system.

Table 2. Group comparison of all parameters at baseline, 6 weeks of the intervention, and 2 weeks post-intervention.

Parameters	Groups	Baseline (1)	6 weeks intervention (2)	2 weeks follow-up (3)	Within group			Between-group	
					(1)VS(2)	(1)VS(3)	(2)VS(3)	6 weeks intervention	2 weeks follow up
Forward shoulder posture (cm)	Control	4.53 ± 0.72	4.71±0.94	4.43±0.70	0.988	1.000	0.617	0.235	1.000
	K-tape	5.32 ± 1.47	4.00±1.16	4.30±1.20	0.001**	0.007**	0.059		
Pectoralis minor index	Control	9.18 ± 0.4	9.30±0.36	9.06±0.53	0.642	1.000	0.372	0.003**	0.008**
	K-tape	9.55 ± 0.72	10.04±0.63	9.70±0.63	0.019*	0.428	0.187		
Upper chest expansion (cm)	Control	6.54 ± 1.02	7.06±0.96	7.25±0.96	0.441	0.107	0.852	<0.001***	0.019*
	K-tape	6.61 ± 0.73	9.20±1.19	8.30±0.94	<0.001***	<0.001***	0.039*		
Middle chest expansion (cm)	Control	5.98 ± 1.33	6.26±1.42	6.22±1.30	1.000	1.000	1.000	0.110	0.116
	K-tape	5.57 ± 0.81	7.46±0.93	7.04±0.94	<0.001***	0.002**	0.149		
Lower chest expansion (cm)	Control	6.72 ± 1.16	7.14±1.32	7.11±1.28	0.266	0.434	1.000	<0.001***	0.02*
	K-tape	6.69 ± 0.76	9.09±0.78	8.04±0.98	0.001**	0.003**	0.251		
Maximum inspiratory pressure (cmH_2O)	Control	51.00 ± 19.54	53.20±18.42	54.92±17.88	0.824	1.000	1.000	1.000	1.000
	K-tape	52.13 ± 22.63	58.71±16.79	60.21±15.14	0.026*	0.011*	1.000		
Maximum expiratory pressure (cmH_2O)	Control	59.93 ± 22.88	64.47±22.57	62.08±17.78	0.272	0.493	1.000	1.000	1.000
	K-tape	63.93 ± 19.19	66.93±21.50	67.57±15.46	1.000	0.763	1.000		

***; p<0.05, **; p<0.01, ***; p<0.001**

The K-tape is generally used to improve musculoskeletal problems among athletes (35, 36). It is based on the proprioception principle, and its primary purposes are to stimulate or restrain some muscular functions, decrease injury, and increase the range of motion via mechanoreceptors in the treatment area (22, 37, 38, 39). In addition, the K-tape intervention can enhance muscular endurance and the flow of cutaneous blood and lymphatic fluid (40, 41). The K-tape is usually stuck on the target part from the muscles' origin to its insertion with 25–50% tension (42). This process stimulates target muscle fiber recruitment and enhances efficiency without causing discomfort or movement limitation. The functional correction technique is well-known for adjusting body posture and encouraging proper movement (43). According to Kase et al. (1996), 50–75% tension of the functional correction technique is effective enough to stimulate proprioception through skin layers, creating posture re-education and realignment (16).

The effects of K-tape on the FSP and PMI. The study's results indicated that using the functional correction technique with K-tape with 50% tension twice a week, six weeks in a row, can improve the FSP. This study was in line with Hajibashi et al. (2014), showing that using the K-tape at the T12 thoracic vertebrae to the acromion process of the scapular with 50% tension for two weeks, together with pectoralis minor muscle stretching, can improve FSP better than solely stretching (25). Similarly, the report from Werasirirat et al. (2018) indicated that using the K-tape with 50% tension at the acromion to the T10 thoracic vertebrae for three weeks can diminish FSP with higher statistical significance than using only tape without tension. The K-tape can activate the cutaneous mechanoreceptor, a sensory receptor on the skin (41). The tension from the tape, via the functional correction technique, would make volunteers feel tension when their shoulder joints are in improper alignment (24). When the FSP occurs, proprioceptive biofeedback would suddenly cause position awareness, where the body learns and adjusts its posture back to appropriate alignment and, thus, decreases symptom severity (32, 33).

Since the FSP is associated with pectoral muscle tightness, the pectoralis minor can pull the acromion process of the anterior scapula tilt forward, causing a limitation in scapular abduction (5). Previous studies have indicated that stretching the pectoralis minor can lengthen the aforementioned muscle and decrease the FSP (12, 43, 44). Moreover, the results of the present study pointed out that the K-tape with the functional correction technique can reduce the FSP and stretch and expand the pectoralis minor since the PMI increases. This finding was in line with Hwang-Bo et al. (2013), in which K-tape was used on the shoulder and the upper back for four weeks (45). The results showed a decrease in the FSP and an increase in the PMI among sedentary workers with upper back pain symptoms. To diminish the FSP and move the shoulder joint back to normal alignment, using the K-tape with the functional correction technique can stimulate the agonist muscles, namely the lower trapezius and serratus anterior, to work more frequently. Then, via the alpha motor neuron, this process activates the spinal cord to signal inhibitory neuronal transmission to antagonist muscles, such as the pectoralis minor (46, 47). This muscle will become loose, making the tight muscles stretch out, thus, diminishing the overlap of actin and myosin in the muscle fibers (48). Therefore, the length of the pectoralis minor muscle increases.

The effects of K-tape on rib cage mobility and respiratory muscle strength. FSP normally leads to tightness of the respiratory muscles, namely the serratus anterior, intercostalis, and pectoralis minor muscles. These muscles are bonded at the chest wall. Tightness of the respiratory muscles can decrease the elasticity of the chest wall, resulting in limitation of the lungs and chest expansion while breathing (49). The investigation conducted by Ghanbari et al. (2008) pointed out that muscle imbalance of the upper extremities, especially tightness of the pectoralis minor, due to the forward shoulder, can limit chest wall mobility while breathing (13). However, several studies have confirmed that body posture correction can improve the respiratory system (50, 51, 52). Excess FSP with thoracic kyphosis and cervical lordosis can limit the contraction of the diaphragm, which is the main muscle contracted while inhaling. A diaphragm that cannot fully contract can become weaker (54). Thus, the present study illustrated the efficiency of the K-tape with the functional correction technique to adjust the FSP and improve chest expansion and respiratory muscle strength.

The findings of this study also showed that using the K-tape to reduce the FSP for six weeks can encourage more chest movement. The magnitude of chest expansion, including the upper, middle, and lower parts, increased, increasing maximum inspiratory pressure, which indicates the strength of the inspiratory muscles (55). However, this investigation could not find a significant change in the MEP, measuring the strength of the expiratory muscles. This finding was similar to the report of Lanza et al. (2013), which stated that chest movement among healthy participants showed a positive correlation with inspiratory muscles and lung capacity (49). The more the chest can move, the better the diaphragm muscle can work while inhaling (55), but the better movement of the chest does not correlate with the expiratory muscles.

Moreover, it is possible that the decrease of FSP in this study does not stimulate the elastic recoil of the lungs or the expiratory muscles. To sum up, adjustment of the FSP using the K-tape with the functional correction technique can make the shoulder return to normal alignment and the body more upright, making the respiratory muscles between the chest wall and ribs stretch out and contract better (56). The chest wall becomes more flexible. The diaphragm muscle, the main muscle for inhaling, has appropriate alignment and length in the maximum contraction period based on the length-tension relationship, enhancing contractions during the inspiratory process (57). The limitation of this present study is the lack of findings that illustrate how much efficiency the K-tape shows toward postural alignment, especially with the vertebrae. In addition, the performance of shoulder joints and respiratory muscles, evaluated by electromyography, is still missing.

CONCLUSION

The functional correction technique using the K-tape, conducted for six weeks with 50% tension, can diminish the FSP, with the effect of the treatment being retained for two weeks. The intervention effect also showed respiratory improvement, including strengthening the inspiratory muscles and expanding the upper, middle, and lower chest regions.

APPLICABLE REMARKS

- The K-tape can be applied to prevent and diminish postural malalignment in athletes and sedentary people.
- Functional correction using the K-tape for forward shoulder reduction can enhance sports performance, endurance capacity, and respiratory muscle strength among individuals.
- The activation of proprioception, blood circulation, and lymphatic movement can be the underlying mechanisms of the K-tape-improved poor posture problems in daily life and sporting events.

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AUTHORS' CONTRIBUTIONS

Conceptualization: KT. Methodology: CS, WV, NC, NK, PL, TJ. Formal analysis: KT. Funding acquisition: KT. Project administration: KT. Visualization: KT, SL. Writing - original draft: KT, SL. Writing - review, and editing: KT, SL. Approval of final manuscript: all authors.

CONFLICT OF INTEREST

The authors declared no conflicts of interest concerning this article's authorship and/or publication.

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