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Original Article

# Therapeutic value of kinesio taping in reducing lower back pain and improving back muscle endurance in adolescents with hemophilia

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**Abstract**

**Objective**: This study evaluated whether the use of kinesio taping (KT) would enhance the effect of physical therapy in relieving pain, improving muscle endurance, and boosting functional capacity in adolescents with hemophilia who experience low back pain. **Methods**: Forty-five adolescents with hemophilia (age; 10-13 years) assigned randomly into three treatment arms; KT applied paraspinal alongside a physical exercise program conducted three times/week for three successive months (KT group; *n*=15), placebo taping plus physical exercise (Placebo group; *n*=15), or physical exercise only (Control group; *n*=15). Lower back pain, back muscle endurance, and functional capacity assessed pre- and post-treatment. **Results**: Lower back pain reduced significantly in the KT group as compared to the control group (*P*=.001), but not to the placebo group (*P*=.19). Back muscle endurance increased significantly in the KT group relative to either the placebo (*P*=.004) or the control group (*P*=.043). Additionally, functional capacity improved significantly in the KT group as compared to the control (*P*=.039) group but not to the placebo group (*P*=.58). **Conclusion**: KT is an effective adjunctive therapy to reduce lower back pain, improve back muscle endurance, and enhance functional capacity in adolescents with hemophilia.

**Keywords:** Endurance, Functional Capacity, Hemophilia, Kinesio Taping, Low Back Pain

## Introduction

Hemophilia is a sex-linked recessive bleeding disorder characterized by a defect in the blood clotting factor[1]. The defect may be in factor VIII (classic hemophilia or hemophilia A) or in factor IX (hemophilia B)[2]. Hemophilia A is the most prevalent type since it has a frequency of 1 in 5000 male births, otherwise, the frequency of hemophilia B is about 1 in 30,000 male births[3]. Inherited defect of plasma proteins involved in blood coagulation generally lead to frequent bleeding disorders, whose severity is inversely proportional to the degree of factor defect; severe if clotting factor activity is less than 1%, moderate if the factor is between 1 and 5% and mild if the factor is more than 5%[4]. Despite hemophilia is rare, being implicated in just a small proportion of the population, it is often associated with high costs and imposes a high health and economic burden on individuals and society in general[5].

In hemophilic patients, lower back pain is a secondary manifestation caused by several factors related to recurrent bleeding in the lower limb joints (i.e. ankles, knees, hips) or muscles (iliopsoas)[6]. These factors include low physical activity levels, habitual poor posture, muscle imbalance, muscle contractures, and insufficient flexibility[6,7]. These factors have been shown to increase the strain on lower back muscles, produce muscle weakness and increase the risk of lower back pain[8]. Taken together, the direct effects of

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hemophilia and the resultant lower back pain can reduce the physical and functional capacity, and aggravate the existing muscle weakness[8]. Several authors studied the relationship between back pain and fatigue[9-12]. They stated that there were specific patterns of back muscle fatigue in subjects with low back pain, who underwent an exercise-induced fatigue test due to high tension or inhibitory mechanism of pain when they were evaluated with electromyography[9,10,12]. Further, the authors observed that people with pain in the lower back show earlier manifestations of muscle fatigue when compared to their healthy controls[11].

The World Federation of Hemophilia described the guidelines for the diagnosis and treatment of hemophilia. Importance of the physical therapy has been reported for hemophilic children with significant musculoskeletal dysfunction to relieve pain, promote normal neuromuscular development, and restore function using a variety of approaches including hydrotherapy, electrical stimulation, ultrasound, pulsed diathermy, orthosis, therapeutic exercises that pay attention to muscle strength, flexibility, physical function, and general fitness, and family- and child-centered education regarding the suitable physical activities[13].

Recently, there is an increasing interest of the health professionals to the use of Kinesio Taping (KT) in the clinical practice as an alternative to the traditional taping and bracing procedures. The rationale for the use of KT is premised on the capability of the taping to improve local circulation, reduce edema, facilitate or relax the muscle, and improve joint function by enhancing the proprioceptive and nociceptive mechanisms, while still allowing full range of motion[14]. KT has been used as a prophylaxis or treatment for muscle strain and bleeds in the sport setting and yielded good results[15,16]. KT has also been used for treating patients with low back pain. Previous studies indicated that KT is an effective adjunctive therapy, besides the traditional physical therapy and exercises, by way of improving pain[17], muscular endurance[17,18], range of motion[19], postural control[20], and disability[21]. However, a recent systematic review found insufficient and inconclusive evidence on the role of KT in the treatment of patients with chronic low back pain[22].

Since the controversy exists on the role of KT in treating low back pain and no or little evidence has been reported on its use in patients with hemophilia, this study was conducted to evaluate whether the use of KT would enhance the effect of physical therapy in relieving pain, improving muscle endurance, and enhancing functional capacity in adolescents with hemophilia who experience low back pain.

## Methods

### Study design

This was a randomized, controlled clinical trial carried out between August 2018 and November 2019. It was conducted at the Outpatient Clinic of College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University (PSAU), Saudi Arabia. Ethical approval was attained from the Physical Therapy Research Ethics Committee at PSAU (No: RHPT/18/0036). All procedures were in accordance with the ethical standards of the 1964 Declaration of Helsinki. Parents or legal guardians of the participants signed a consent form before the baseline assessment. The examiner was blinded to the group assignments.

### Subjects

Forty-five boys with hemophilia were recruited from King Khalid Hospital and other referral hospitals in Al-Kharj, Saudi Arabia. Children were included if their ages ranged from 10 to 13 years, had moderate hemophilia type A, received the factor replacement therapy (i.e., recombinant factor VIII replacement), experienced low back pain for more than one month before enrollment, didn't have enduring, disabling pain, had an approval from the attending physician to stop pain medications during the study, were free of contractures or any congenital deformities, and if they had no cardiopulmonary dysfunctions. Children who had the last bleeding episode in the last month and those with advanced radiographic changes as bone erosions, destruction, bony ankylosis or joint subluxation or who had been suffering from combined back deformity as kyphoscoliosis were excluded. In addition, children who received analgesic medications in the past month and those who were advised against participation in physical activities by their physicians were excluded.

### Assignment procedure

Subjects were assigned randomly into three treatment arms; kinesio taping plus physical exercises (KT group; *n*=15), placebo taping plus physical exercises (Placebo group; *n*=15), or physical exercises only (Control group; *n*=15). A simple randomization technique was employed and performed by an independent researcher. Participants were assigned consecutive numbers from 1 to 45, then a web-based research randomizer[23] was used to generate three equal subsets of these numbers, the resulting subsets were allocated randomly to the treatment arms.

### Sample size estimation

To identify the proper sample size, a power analysis was conducted before data collection using G-power software (version 3.1.9.2; Dusseldorf, Germany). In a one-way design (ANOVA test), a group-sample of 12 subjects was required (i.e., a total sample of 36 subjects) to achieve 90% power to detect differences between the means against the alternative of equivalent means using an F test with an alpha level of .05. Based on findings from a pilot study, the size of variation in the means was represented by their SD which was 0.70. The common SD within a group was assumed to be 1.12. We recruited up to 45 subjects expecting that 25% of the subjects will be lost.

## Outcome measures

Pain, lower back muscle endurance, and functional capacity were measured before and after treatment by an independent researcher who was not aware of the group treatment.

The degree of pain was evaluated using the numeric rating scale (NRS-11). It is a self-reported pain-measuring instrument that is reliably used for adolescents with hemophilia[24,25], and other chronic musculoskeletal conditions[26]. Each subject was required to choose the number, that best reflects the intensity of pain he experiences on a horizontal 10-cm line that was anchored by 0-10 integers, where 0 represents "no pain", 5 means "moderate pain, and 10 refers to "worst pain".

The lower back muscle endurance was assessed by applying the Biering-Sorensen test. Test validity and reliability have been established[27]. Each subject was initially placed in a prone lying position on the treatment table with the iliac crest at the edge while another hydraulic table was simultaneously placed under the trunk and upper body at the same height as the stationary table. Three Velcro straps were applied to fix the lower limbs to the table at the horizontal position with the ankle in plantar flexion. Straps were located at the level of the greater trochanter, popliteal fossa, and tendo-achilles insertion just above the ankle joint, each was independently tightened until the subject felt complete immobilization. To measure in changes trunk flexion/extension during the test, a bi-level inclinometer (Isomed Inc, Kirkland WA, USA) was fixed on the back between the two scapulae with elastic band and was set at 0° while the subject fully supported (arms were relaxed in the external rotation, shoulder abducted to 90°, elbow flexed to 90°, forearm pronated, and the head was turned to one side for relaxation). For testing, the hydraulic table lowered, the subject's ability to maintain a horizontal position while placing both arms across the chest was assessed using a stopwatch to measure the time before trunk muscle failure and verbal command was provided to encourage the patient to keep the neutral position or the inclinometer at 0°. Neither the subject nor the examiner was aware of the time passed at any point during the test. Trunk oscillation within 10° (5° extension and 5° flexion) was acceptable. When any part of the subject's upper limb touched the table or when he was unable to resume the test position even with verbal encouragement the inclinometer was stopped, and the test was finished[28]. Before actual testing, an orientation session for the testing procedure was acknowledged for each subject in a separate day.

Functional capacity was measured using the 6-min walk test. It is a submaximal test which was determined as being a useful tool for children with chronic musculoskeletal conditions[29]. Subjects were required to walk as far as possible through a 50-meter straight corridor over a span of six minutes, while the examiner closely following them with a stopwatch. Prior to measurement, subjects were explained about the purpose of the test and were shown the start and endpoints. They were instructed to avoid hopping, running, or jumping. A single test was performed on all subjects at each assessment occasion[30].

## Intervention

### Taping techniques

For the KT group, two, 10-cm stripes of the Kinesio tape were applied by way of "I" shape on each side of the limber spine, from the sacrum (at the posterior superior iliac spine level) through the transverse process of 12$^{th}$ thoracic vertebra on the same side. The tape was measured while the trunk was maximally flexed within the limit of pain. The first 2.5 cm of tape was removed carefully from its paper backing, the caudal end of the tape was secured to the sacrum with 0% traction while the child in the neutral upright standing, then the child was asked to maximally flex the trunk, fully extend the knees, while keeping feet together, the tape was then stretched (50%) and applied on the paraspinal muscles, except for the final 2.5 cm of the proximal end of the tape, which was attached without tension after the subject re-assumed the neutral upright standing. Taping was applied sequentially on either side with the same procedure. We estimated 50% tension of the tape during trunk flexion according to guidelines by the manufacturer, which recommend anywhere from 50% to 100% tape stretch for muscle "facilitation", and also because 50% tension has been purported to be the key component to any potential therapeutic benefit of KT[31]. For the placebo group, 10-cm stripes from the same tape were applied in the same way between the previously mentioned anatomical landmarks, but with 0% tension[32,33]. The tape was changed every two days before exercises, while children were attending the physical exercise session.

### Physical exercises

All groups received a 30-minute exercise program, three times per week in non-consecutive days, over 12 successive weeks. The program was conducted by three pediatric physical therapists in the Physical Therapy Outpatient Clinic according to the guidelines described by the World Federation of Hemophilia[13], and was adopted from a previous report on the effective physical treatment for chronic low back pain[34]. The focus of the program was to control pain, maintain/restore lumber segment mobility and soft tissue extensibility, improve muscular strength and endurance, and improve physical activity level. The exercise program included the following:

- Stretching exercises for the lower back extensor, iliopsoas, and hamstring muscles. The physical therapist applied a 30-second gentle stretch for each group followed by a 30-second release (2 sets/3 repetitions; one set was applied at the beginning of the session and the other one at the end).
- Strengthening exercises for abdominal muscles. Each subject performed active leg raise, abdominal crunch, side crunch and bicycle crunch (1 set/10 repetition for each

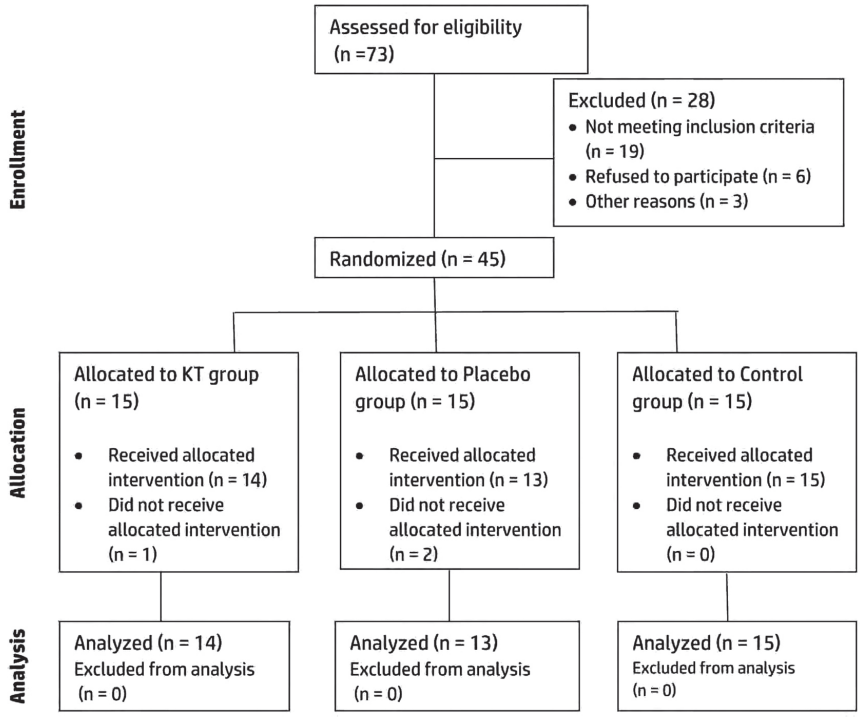


**Figure 1.** Participants' flow diagram.

**Table 1.** Baseline descriptive statistics of the study groups.

| | KT group (n=15) | Placebo group (*n*=15) | Control group (*n*=15) | *P*-value |
|---|---|---|---|---|
| Age, *year* | 11.80 ± 0.94 | 11.33 ± 1.32 | 12.13 ± 0.83 | .11 |
| Weight, *Kg* | 35.67 ± 3.83 | 36.13 ± 3.72 | 37.47 ± 3.34 | .38 |
| Height, *m* | 1.35 ± 0.06 | 1.34 ± 0.07 | 1.37 ± 0.06 | .57 |
| BMI, $Kg/m^2$ | 19.43 ± 0.83 | 19.98 ± 1.20 | 20.02 ± 0.90 | .21 |
| Bleedings in last 12 months, *n* | 1 (0 – 2.4) | 2 (0.6 – 3) | 2 (0 – 3.4) | .08 |
| Pain medication usage (never/ occasional/frequent), *n* | 6/8/1 | 8/5/2 | 10/3/2 | .47 |
| Factor replacement (prophylaxis/ on-demand), *n* | 5/10 | 7/8 | 6/9 | .93 |
| Duration of lower back pain, *days* | 92.53 ± 33.12 | 84.47 ± 30.02 | 102.27 ± 21.92 | .25 |
| *Data expressed as mean ± SD, bleedings in last 12 months expressed as median (10-90 percentile), BMI: body mass index.* | | | | |

exercise, with a 5-second hold). This was proceeded by ten, 5-sec isometric contractions of the abdominal muscles with rest intervals of 5-sec.

- Brisk walking program on a treadmill or use of stationary bicycle/stair stepper according to the preference of each subject (~10 -15 minutes).

In addition, a home program was developed within the tolerance and ability of each subject to encourage continued exercise. The program was performed for 30-minutes on days the subjects didn't attend for the treatment in the clinical setting. They were instructed to perform a group of self-stretching exercises, active trunk flexion exercises, and conditioning exercises (walking for 10-15 minutes).

## Statistical analysis

All statistical tests were performed through the windows package of SPSS software, version 26 (SPSS Inc, Chicago, IL), with a significance level accepted at $P<.05$. Data normality was confirmed by means of the Kolmogorov-Smirnov test.

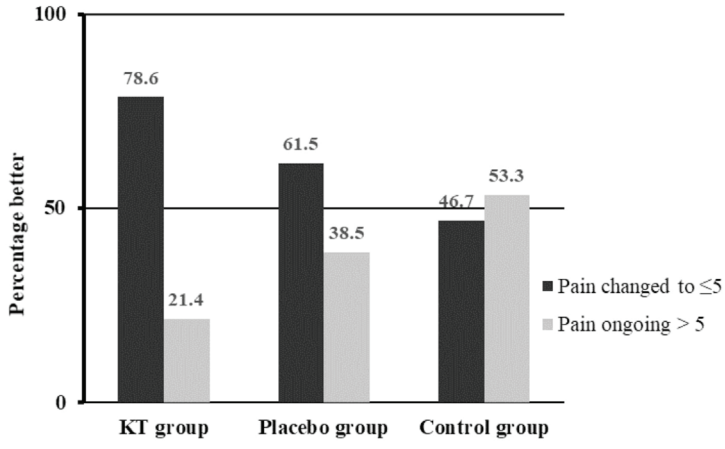


**Figure 2.** Proportion of adolescents with post-treatment pain levels changed to ≤5 versus those with ongoing pain >5 in the study groups.

**Table 2.** Visual analogue pain scores for the study groups.

| | KT group (*n*=14) | Placebo group (*n*=13) | Control group (*n*=15) | *F* (2,39) | *P*-value |
|---|---|---|---|---|---|
| Pre | 6.93 ± 1.07 | 6.54 ± 0.97 | 7.33 ± 0.72 | 2.568 | .09 |
| Post | 4.43 ± 1.28 | 5.23 ± 0.73 | 6.13 ± 1.36 | 7.696 | .002* |
| *T*-value | 6.009 | 3.157 | 3.154 | | |
| *P*-value | <.001¥ | .008¥ | .007¥ | | |
| Cohen's *d* | 1.61 | 0.87 | 0.81 | | |

*Data expressed as mean ± SD, * significant ANOVA test (between-group difference), ¥significant paired t-test (within-group difference).*

Between-group differences were analyzed using the one-way ANOVA test. When the null hypothesis of equality is rejected in the ANOVA test, a pairwise comparison of all possible pairs of group means was undertaken using Tukey's honestly significant difference test to determine the form of inequality. Within-group differences were calculated via the paired *t*-test. Where the t-test was revealed a significant within-group difference, the effect size was estimated through Cohen's formula.

## Results

Seventy-three patients with hemophilia were initially screened. Of whom, 45 met the eligibility criteria and were consented and took place in the randomization phase. However, we lost three participants during the study (one participant in the KT group didn't attend the post-treatment evaluation and two participants in the placebo group didn't complete the treatment). Hence, 42 participants successfully completed the study and their data were analyzed (Figure 1; participants flow diagram). The baseline descriptive data are presented in Table 1. There were no significant differences between the study group regarding age, anthropometry (weight, height, and BMI), frequency of bleeding episodes in the last 12 months, pain medication usage, coagulation factor replacement regimen (prophylactic versus on-demand), pain medication usage, and the duration since back pain symptoms were appeared (*P*>.05). Children were assessed every 48 hours for skin allergy while the tape was changed. We found no adverse effect to report.

The visual analogue pain scores are shown in Table 2. The study groups were similar, pre-treatment (*P*=.09). Post-treatment, pain levels decreased significantly in KT (*P*<.001), placebo (*P*=.008), and control (*P*=.007) groups compared to the pre-treatment levels. The post-treatment levels of pain were significantly different among the study groups (*P*=.002). The pairwise comparison indicated that pain reduction was greater in the KT group when compared to the control group (*P*=.001) but not to the placebo group (*P*=.19). However, the proportion of adolescents with pain levels changed to ≤5 versus those with ongoing pain >5 was not different among the study groups (Pearson $\chi^2$=3.127, *P*=.23). The pain changed to ≤5 in 26 participants (KT; 11, placebo; 8, and control; 7) while the pain remained >5 in 18 participants (KT; 3, placebo; 5, and control; 8) (Figure 2).

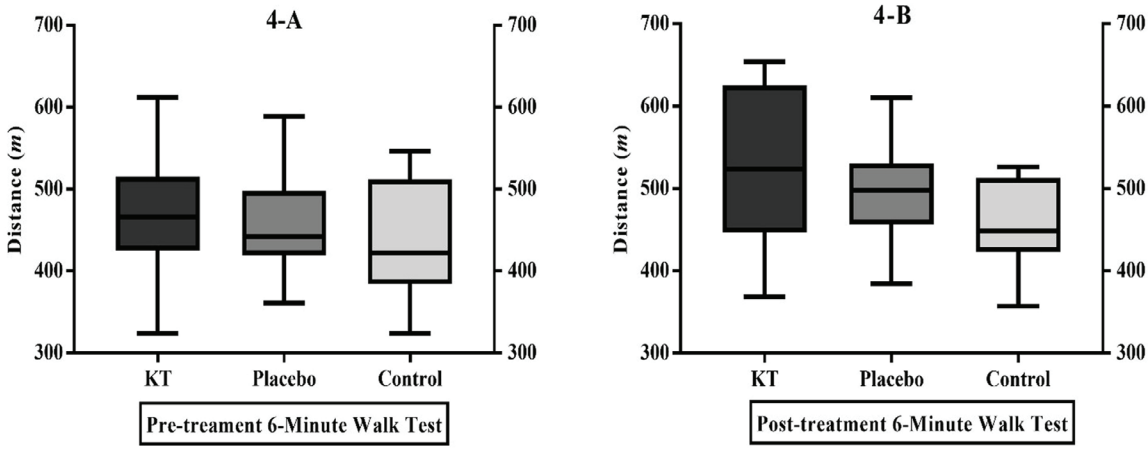


**Figure 3.** Distance covered in the 6-minute walk test (m) in the study groups at the baseline (4-A) and post-treatment (4-B).

**Table 3.** Mean endurance time (seconds) of lower back muscles in the Biering-Sorensen test for the study groups.

| | KT group (*n*=14) | Placebo group (*n*=13) | Control group (*n*=15) | *F* (2,39) | *P*-value |
|---|---|---|---|---|---|
| Pre | 76.93 ± 13.44 | 74.31 ± 15.52 | 83.27 ± 12.91 | 1.553 | .22 |
| Post | 96.64 ± 10.48 | 82.38 ± 14.10 | 86.47 ± 7.89 | 6.140 | .005* |
| *T*-value | -10.223 | -2.324 | -1.436 | | |
| *P*-value | <.001¥ | .039¥ | .17 | | |
| Cohen's *d* | 2.73 | 0.64 | - | | |

*Data expressed as mean ± SD, * significant ANOVA test (between-group difference), ¥significant paired t-test (within-group difference).*

The mean endurance time of lower back muscles in the Biering-Sorensen test is reported in Table 3. The pre-treatment endurance time for the study groups was comparable (*P*=.22). The post-treatment endurance time increased significantly in the KT group (*P*<.001) and placebo group (*P*=.039) in comparison with the pre-treatment time but didn't change in the control group (*P*=.17). The post-treatment endurance time was significantly different between groups (*P*=.005). The time increased significantly in the KT group when compared to the placebo (*P*=.004) or control group (*P*=.043).

The mean distance (95% confidence interval of the means) covered during the 6-min walk test is illustrated in Figure 3. The study groups covered relative distances during the pre-treatment test (*F* [2,39]=0.787, *P*=.46). From the pre- to post-treatment, the distance increased significantly in the KT group (*P*=.002) but the difference didn't achieve the statistical significance in the placebo group (*P*=.075) and the control group (*P*=.059). Post-treatment, groups were significantly different (*F* [2,39]=0.3.266, *P*=.048). The KT group covered longer distances than the control (*P*=.039) group but not the placebo group (*P*=.58).

## Discussion

The results of this study showed a reduction in pain intensity in the KT and placebo groups, but only the KT group showed a meaningful improvement in relation to the control group. It has been also indicated that the KT group achieved a greater increase in the back muscles' endurance, as they were able to maintain their trunk in the neutral position in Biering–Sorensen test for a significantly longer time than did the placebo or control groups. Further, the KT group gained higher functional capacity, as indicated by the covered distance in the 6-min walk test than the control group.

In agreement with our results, Castro-Sánchez et al demonstrated that the application of KT paraspinal on the lumber region produced a greater reduction in pain levels than placebo taping in a sample of 60 patients with chronic low back pain[17]. In a recent study, Macedo et al have also observed remarkable pain relief after the application of KT with and without tension when compared to no-taping in patients with chronic low back pain[35]. The same was seen in a study by Paoloni et al, where significant pain relief was reported shortly and at four weeks after application of KT alone over the lumbar erector spinae muscles bilaterally or

in combination with exercises[36]. The results of this study also corroborate with several authors, who generally noted a significant improvement of low back pain after KT[37-40].

In terms of back muscles' endurance, a previous study by Alvarez et al assessed the effect of KT on back muscles' endurance[18]. The results of that study revealed that applying KT considerably increased the time-to-failure of the muscles of the back in asymptomatic individuals during the Biering-Sorensen test, indicating that KT may have an effect on the processes that lead to early muscle fatigue and that KT can be an effective method in treating lower back pain. A randomized, controlled, crossover trial by Hagen et al investigated the effect of KT versus no taping or rigid therapeutic taping conditions on back muscle endurance, using the Biering-Sorensen test, in a sample of 16 symptomatic patients suffering from chronic low back pain[33]. The study reported a statistically significant difference between the KT and no-taping conditions favoring the KT condition, and a non-significant difference between the KT and rigid therapeutic taping conditions. An earlier study by Nosaka stated that KT normalizes muscle tension, increases the concentric muscle strength and static contraction[41]. Increased muscle strength might be the reason for the improvement in the current study, especially since hemophilic patients who experience chronic back pain have been shown to have abnormal back muscle activity[42]. However, more clinical studies are still needed to investigate the effect of KT on muscle performance.

To our knowledge, no previous studies evaluated the effect of KT on functional capacity using the 6-min walk test. However, some authors have used a variety of other measures to assess functional disability after the application of KT and reported significant improvement in function[35,37]. Given the relationship between the functional limitation with pain and poor muscle performance[43], it could be suggested that the pain relief and KT-induced enhancement of the proprioceptive feedback helped individuals with low back pain to maintain postural alignment and increase awareness of the back during movement, contributing to the overall improvement in the functional capacity.

Although the mechanism by which the KT reduces pain and alleviate muscle weakness is beyond the scope of this study, it has been suggested that the mechanical stimulus (i.e. microscopic skin-lift) induced by the KT acts through the large-diameter non-nociceptive nerve fibers, which in turn facilitate pain inhibitory mechanisms (pain gate control theory) and pain reduction. This microscopic skin-lift increases the interstitial spaces and permits greater blood and lymph flow, which can assist in drainage of the analgesic substances and activation of the endogenous analgesic system, resulting in pain relief[31,36]. Also, KT is claimed to decompress the nociceptors[44], which helps reduce levels of pain and improve their capability to decrease the mechanical irritation of soft tissues when moving the lumbar spine[31]. Further, Konishi suggested that the tactile stimulation produced by the KT compensates for decreased input to gamma motor neurons, modulates the sensitivity of the muscle spindles, and indirectly increases the feedback from the spindle primary afferents (Ia), and this could provoke the activities of alpha motor neurons, thus inhibiting the decline in muscle strength[45].

The current study had some limitations. In the Biering Sorensen test, several trunk stabilizer muscles (including multifidus, gluteus maximus, biceps femoris, and abdominal muscles), in addition to the paraspinal muscles, have been suggested to contribute to maintaining the neutral trunk position. Further, the amount of time that the individual can hold the trunk position is the only possible measure that the test considers, which may be insufficient to specify the back muscle performance[18,46]. So, further researches needed using different tests combined with Biering Sorensen test as EMG or isokinetic apparatus to give more specific and accurate data about the back-muscle endurance. Also, our results cannot confirm the long-term effect of the KT. Therefore, the forthcoming studies should consider to follow-up the effect 6-12 months after the end of treatment. It is important to note that the findings of this study are limited to adolescents with hemophilia who aged 10-13 years old and should be applied with caution to other age groups. Possibly, future studies need to include samples of different age groups to confirm the results of this study and to provide more generalizable results.

## Conclusion

In conformity of the findings of this study, KT was effective in reducing pain and lower back muscles' fatigue and improving functional capacity in adolescents with hemophilia, so that it can be added safely to the physical therapy program for adolescents with hemophilia who experience back pain and lower back muscle fatigue.

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