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Effects of kinesio taping on tuck jump performance in competitive male athletes.

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Running head: Acute effects of Kinesio taping on jump performance.

Effects of kinesio taping on tuck jump performance in competitive male athletes.

Abstract

This study aimed to measure the acute effects of Kinesio taping at different stretches on tuck jump performance in active individuals. Seventy-five males (23.01 ± 2.24 years, 178.35 ± 8.12 cm, 72.47 ± 6.58 kg) were randomly distributed into three groups: (1) Kinesio taping without stretch, (2) Kinesio taping with approximately 50% stretch, and (3) Kinesio taping with approximately 75% stretch. The tuck jump performance of all participants was determined at baseline, immediately after applying Kinesio taping, and 24 and 72 hours later. The participants' tuck jump performance did not improve immediately after the Kinesio taping application, 24 hours and 72 hours after the application. No significant differences were found between the Kinesio taping groups at any time point ($p>0.05$). This study demonstrated no effects of Kinesio taping on neuromuscular performance.

Keywords: Kinesiology taping; tuck jump; neuromuscular control.

Introduction

A combination of anatomical, neuromuscular, and biomechanical factors have been recognized to contribute to non-contact knee injuries, some of which are modifiable [1-3]. A number of biomechanical factors during landing such as ipsilateral trunk motion, pelvic drop, hip adduction and internal rotation, knee valgus, tibial internal or external rotation and external hip adduction moment have been reported as risk factors for knee injury [4-10].

Dynamic sports-related movements can result in lower extremity injuries if athletes exhibit neuromuscular performance deficits [11]. Researchers have classified and outlined neuromuscular deficits into four groups using video analysis. These groups include ligament dominance, quadriceps dominance, leg dominance, and trunk dominance [12]. Specifically, ligament dominance is an imbalance between the neuromuscular and ligamentous controls of dynamic knee joint stability [12, 13]. This imbalance is represented by an inability to control lower extremity frontal plane motion during landing and cutting [12, 13]. Quadriceps dominance is also an imbalance between knee extensor and flexor strength, recruitment, and coordination [12, 13]. Leg dominance is reported as another imbalance between the lower extremities in strength, coordination, and control. Finally, trunk dominance is considered one of these very imbalances, which occurs between the inertial demands of the trunk and control and coordination to resist it [12, 13]. These four potential neuromuscular control deficits have been declared as risk factors that significantly contribute to injuries in athletes [13]. Tuck jump assessment was designed as a clinician-friendly tool to provide practitioners and clinicians with a novel direction to identify neuromuscular imbalances highly associated with injury [14].

Kinesio taping (KT) is an elastic therapeutic tape used to prevent and treat sports injuries and various musculoskeletal conditions and may help alleviate some neuromuscular control deficits

[15, 16]. KT is adopted to improve function, stability, and proprioception [17-19] and enhance muscle contraction and force production in painful musculoskeletal conditions [15, 19, 20]. By improving proprioception and muscle activation, KT may favorably influence injury risk [19, 21, 22]. Applying KT at a stretch greater than 50% can help correct the knee valgus position [19, 21] and improve jump performance [18, 23]. Other studies have reported limited, inconclusive evidence regarding the effectiveness of KT on muscle strength and functional performance [17, 23, 24].

Some studies noted increased electromyographic activity of the muscles at 24 and 72 hours after applying KT [25, 26]. The results of these studies raise the hypothesis of possible delayed effects of KT application on neuromuscular performance [27, 28], offering the possibility for new research. Generally, the working mechanism of KT remains unknown. The effects of KT on motor performance may be due to the interplay between cutaneous afferent stimulation and motor unit firing in both central and peripheral nervous systems [29]. An increase in peripheral nerve stimulation was shown to promote the excitability of the motor cortex [29]. Therefore, reduction of motor neuron threshold may be induced by cutaneous stimulation, resulting in easier recruitment of the motor units, and in turn, leading to an improved performance [30, 31]. However, previous studies indicate that applying KT to the muscles does not alter the neuromuscular performance or lower limb function in healthy participants [30, 31].

In the context of improving neuromuscular performance, less attention has been devoted to the influence of KT on neuromuscular control deficits during jump tasks. The hypothesis that KT, leading to improved neuromuscular control deficits, will improve athlete's performance needs to be formally verified. Therefore, we designed a randomized controlled trial (RCT) to evaluate the acute effects of KT at different stretches on neuromuscular performance in athletes. The present

study aimed to compare the acute effects of Kinesio taping at different stretches on tuck jump performance in active individuals. We hypothesized that KT would improve neuromuscular performance in athletes.

Materials & Methods

Seventy-five competitive males participated in this RCT retrospectively registered at [UMIN000044935, date of first registration 21/07/2021]. Sample size calculations were performed using G*Power (version 3.1.9.2, Dusseldorf, Germany). In accordance with previous evidence [21, 32, 33], a medium effect size ($f = 0.25$), an alpha level of 0.05, and a power of 0.80 were considered. The calculation revealed that 22 participants were required in each group. Twenty-five competitive males were included in each group to account for possible missing data and a 15% loss from participants missing follow-ups.

The research ethics committee of the Sport Sciences Research Institute (Approval ID: SSRI.REC-2106-1072) approved this study. All participants were informed of the study procedures and signed an informed consent form before participating, in conformity with the Declaration of Helsinki [34].

Inclusion criteria included: no history of surgery in the lower extremity in the previous before study participation, no musculoskeletal injury that could interfere with or contraindicate the assessment procedures [23, 35], and no allergy to the adhesive material used [30]. In addition, the exclusion criteria were: current pain in the lumbar spine and lower limb, cardiac disorders, vestibular conditions and neurological abnormalities [23, 35, 36].

Procedures

Demographic information, including age, body height and mass, was collected during the assessment. Before randomization, the demographic data of all participants were collected and recorded by a blinded assessor. After the assessment, the participants were randomly assigned into one of three groups: KT without stretch (KT0), KT with approximately 50% and 75% stretch (KT50 and KT75, respectively) using the website <http://randomizer.org/> (Social Psychology Network, Connecticut, USA). Concealed allocation was performed using a computer-generated block randomized table of numbers (1; KT0 group, 2; KT50 group and 3; KT75 group). All participants were evaluated daily at the same time in a laboratory. The experimental conditions were controlled for the ambient temperature (24°C), lighting and humidity. All participants were asked to refrain from training, maintain a regular diet and sleep routine, and avoid smoking, caffeine and alcohol for 24 hours before testing sessions. All participants' tuck jump performance was assessed using different KT stretches (three groups: KT0, KT50 and KT75) at baseline, immediately after the application of KT, 24 and 72 h after the application of KT (Figure 1). The randomization was performed by a researcher who was not involved in the recruitment or interventions of participants.

-insert Figure 1 here-

Kinesiology Taping Application

The examiner measured the distances between the muscle origin and insertion of all participants with a meter to determine the stretch imposed during the KT (Kinesio Tex Gold, FP, 5 cm wide) application. After the measure, the mathematical rule of three was used to determine and individualize the length of the KT [23]. Percentages are listed as the percentage of stretch to be applied based on 100% of the available stretch. For example, 50-75%. The meaning of this is 50-75% of the available stretch, with 100% being the maximum stretch. Finally, KT was applied to

the participants' muscles according to the established stretch, bilaterally on the lower extremity muscles, by the same trained researcher who was a certified KT practitioner with 8 years of experience using KT. Moreover, the KT was applied to all major muscles responsible for jump landing [37] (gastrocnemius [GT], biceps femoris [BF], vastus lateralis [VL], vastus medialis [VM], rectus femoris [RF] and gluteus medius [Gmed]) (Figure 2). Before applying the KT adhesive, hairs were removed, and the skin was cleaned with alcohol (70% isopropyl alcohol pads) to ensure KT adherence. In addition, the participants' skin sensitivity was controlled with a KT test patch for 24 h [23].

The KT was applied to the muscles as follows.

For the GT, the participant was relaxed in the prone position; the KT was split into a Y-strip so that each side could be longitudinally taped along the origin of the medial and lateral GT muscles. Both proximal ends of the Y-strip were placed, without stretch, 4 cm below the popliteal line, with the ankle in the neutral position. The proximal half of the strip was then stretched and placed on the calf up to the marked midpoint, with the participant's ankle at maximum dorsiflexion. The distal half of the strip was also stretched and placed from the midpoint to the upper part of the posterior calcaneus tuberosity, with the participants' ankles still at maximum dorsiflexion. The distal end of the Y-strip was then placed, without stretch, with the ankle back in the neutral position [38].

For the BF, the participants were positioned lying on their sides with the hip flexed and internally rotated, the knee extended, and the contralateral leg slightly bent for stability. In addition, the KT was applied from the ischial tuberosity to the posterior region of the fibular head.

For the VL muscle, the KT was applied 10 cm distal to the greater trochanter, extending to the lateral edge of the patella. Next, the KT was applied to the RF from 10 cm below the anterior

superior iliac spine to the upper edge of the patella, with the participant in a relaxed supine position [23]. The strip was fixed on the VL muscle from the greater trochanter to the lateral edge of the patella. Finally, the KT was applied to the middle third of the medial region of the thigh to the medial edge of the patella for the VM. This application was performed with the participants standing on one foot, with the hip of the dominant limb at 0° and the knee flexed at 90° [30]. Moreover, the KT was applied to the quadriceps from the proximal attachment to the distal one [15].

For the Gmed, the KT was applied from the iliac crest to the greater trochanter in the side-lying position. The participants were in a side-lying position with 90° hip flexion, adduction, and internal rotation. The KT was applied from muscle insertion to origin using the Y-strip taping technique. The base of the Y strip was additionally applied on the lateral surface of the greater trochanter with no stretch. The anterior tail was applied towards the anterior superior iliac spine, with light or paper-off-technique stretch and the last 1–2 inches with no stretch. The posterior tail was also applied towards the posterior superior iliac spine with a similar stretch as mentioned above [15, 19].

-insert Figure 2 here-

Two-Dimensional Video Analysis

The performance was captured with two standard digital video cameras (Sony HDR-PJ675) sampling at 48 Hz on tripods with a height set to that of the participant's waist. One was aligned 2 m away in the sagittal plane, and the other was aligned 2 m away in the frontal plane. The video recordings were analyzed using a commercial software package (Kinovea version 0.8.15) [39]. The participants were required to wear shorts with the hem approximately mid-thigh [14] to allow

visible tracking of the knees. Markers were appropriately positioned on the acromioclavicular joint, manubrium sterni, anterior superior iliac spine, greater trochanter, and medial and lateral femoral epicondyles, medial and lateral malleoli. The ankle joint center was defined at the midpoint of the medial and lateral malleoli markers. The knee joint center was also identified at the midpoint of the medial and lateral femoral epicondyle markers [39]. The knee valgus angle was described as the angle between the line formed by the knee joint center and the ankle joint center and the line formed by the anterior superior iliac spine (ASIS) and the knee joint center. The reliability of two-dimensional video assessment has been previously confirmed (ICC= 0.72 to 0.91) [40].

Tuck Jump Assessment

All participants completed the same 15 min post-activation potentiation (PAP) warm-up strategies [41, 42]. It consisted of multidirectional movements combined with strength and dynamic stretching exercises (5 min), maximal- and progressive-intensity displacements (5 min), including change of directions (2 min), jumps (2×5 repetitions), and acceleration/deceleration movements (2×5 repetitions) [41, 42]. During the familiarization session, the participants received instructions on performing the test, including cues to lift the knees to hip height and land on the same spot. A demonstration of the exercise was also provided. The participants were allowed to practice no more than two trials of the tuck jump prior to data collection. Furthermore, the participants were instructed to place their feet in the middle of a rectangle marked on the floor while performing the assessment. This square consisted of four smaller rectangles (41 cm in length and 35 cm in width). The number of jumps in 10 seconds was recorded. Three trials were completed with a 2-minute rest between trials. These values were averaged across the 3 successful

174 trials for each task and used for statistical analysis. The tuck jump assessment score has been
 175 shown to be reliable (ICC= 0.85 to 0.88) for assessing neuromuscular control in healthy adult
 176 athletes [43].

177 After the test, all videos were reviewed, and 10 flaws a participant may have displayed during the
 178 jumps were scored (Table 1). The overall score of the tuck jumps was the sum of the total number
 179 of flaws observed [13, 14]. Evidence suggests that these neuromuscular deficits may be associated
 180 with anterior cruciate ligament (ACL) injury [12, 13]. Therefore, these deficits should be examined
 181 and identified in individual athletes [12, 13]. A second investigator performed all tuck jump
 182 quality assessments and was blinded to the specific condition being evaluated.

184 **Statistical Analysis**

185 The Kolmogorov–Smirnov test was used to confirm the normality of the data; Levene’s test
 186 evaluated the homogeneity of variances. Group demographics were compared using a one-way
 187 analysis of variance (ANOVA). The mean, standard deviation (SD), and 95% confidence intervals
 188 (95%CI) were calculated. Linear mixed models were used for each KT stretch to compare
 189 differences between the tuck jump test score and the four assessment time points (3 conditions
 190 [Tape without stretch, Tape at 50%, Tape at 75%] \times 4 Tests [pretest, posttest-1, posttest-2,
 191 posttest-3]). Furthermore, the magnitudes of the differences were examined using the standardized
 192 difference based on Hedges *g* units using effect sizes. The effect size results were qualitatively
 193 interpreted using the following thresholds: standardized mean differences of 0.2, 0.5, and 0.8 for
 194 small, moderate, and large effect sizes, respectively [44]. Statistical significance was set a priori at
 195 $p < 0.05$. All analyses were conducted using the SPSS Version 23.0 (Chicago, IL, USA).

197 **Results**

Seven participants (KT0 group [$n = 3$], KT50 group [$n = 2$], and KT75 group [$n = 2$]) did not complete the assessment protocol since they missed one of the assessments. Therefore, 68 participants were analyzed. No adverse events occurred in any KT group.

The mean and standard deviation of the participant's demographic characteristics are presented in Table 2. At baseline, there were no significant differences in the demographic characteristics and the scores of tuck jump between the three groups; all the tested variables showed $p > 0.05$. The frequency distribution of individual tuck jump assessment criteria for the three groups at the four-time point is displayed in Figure 3.

-insert Table 2 here-

-insert Figure 3 here-

No significant effect of KT on tuck jump performance was found ($p > 0.05$). General linear mixed model analysis showed no significant group \times time interaction effect for tuck jump performance ($F = 0.08$, $p = 0.99$). The effect size ranged from small ($g = 0.28$) to moderate ($g = 0.69$). The participants' tuck jump performance was not improved immediately after the application of KT, 24 h and 72 h. No significant differences were found between the KT groups at any of the time points ($p > 0.05$) (Table 3).

-insert Table 3 here-

Discussion

This study aimed to investigate the effects of KT at different stretches on the tuck jump performance of competitive male athletes. As the main finding, our RCT revealed that applying a KT 0%, 50%, and 75% stretch did not improve tuck jump performance.

To the best of our knowledge, this is the first study to investigate KT's effect at different stretches on jumping performance despite growing research investigating the KT effect on lower limb

functions in injured and healthy individuals [17, 18, 23, 30]. For example, Jesus et al. [23] conducted a similar study. Their findings demonstrated that different types of KT stretches did not modulate the quadriceps isometric strength or single-hop tests in the short or the long term in healthy participants [17, 23]. Furthermore, current studies have shown that the direction of KT cannot reduce or enhance muscle activity [24]. A recent study also examined vertical jump performance in healthy young adults failing to find significant differences in jump performance [45]. Opposite to our finding, Limroongreungrat et al. [46] showed that using the ACL-KT technique with 75% stretch can change the drop vertical jump task pattern in healthy people. While the potential working mechanism of KT may be reflected after a longer application time [18], our results demonstrated that the KT application did not affect the tuck jump score after 24 h, 72 h, thus leaving open the debate on its effect. KT has been proposed to provide tactile stimulation [47, 48]. However, KT tactile inputs may not be strong enough to modulate muscular strength and biomechanical/technical aspects of jumping in healthy athletes [49]. In addition, it has been suggested that KT can add proprioceptive information, stimulating Golgi tendon organs and muscle spindles during voluntary movement and functional tasks. Muscle spindles and Golgi tendon organs may send sensory information to the central nervous system to facilitate an early activation response from the muscles (e.g., of the trunk and lower extremity) [18, 50-55]. Recently, the contextual effects and the rituality presented during the application of the KT (e.g., the rituality of the colour, the shape and the length of the tape) were also proposed to explain its effect [56]. Nonetheless, the basic KT application mechanisms have yet to be thoroughly investigated, offering opportunities for future research.

This study has some limitations that should be considered when interpreting its results. First, this study had no control group (without KT) or a sham group (with a fake KT), thus preventing the

245 possibility of checking the role of confounders and placebo effects [57]. Second, the athletes
246 assessed herein were not blinded to their KT stretches applied to the adhesive tape. Third, this
247 study did not investigate sex-specific neuromuscular performance changes. Finally, this study did
248 not measure changes in muscle activation. Thus, future studies should explore the effect of KT
249 application on the electromyographic activity of lower extremity muscles during sports associated
250 with ACL injury occurrences and other musculoskeletal conditions (e.g., low back pain) [58, 59].
251 In summary, this study demonstrated no effects on the neuromuscular jump performance after the
252 different stretch applications of KT. Therefore, compelling evidence is lacking to support using KT
253 to enhance neuromuscular performance. Further research is needed to investigate the efficacy of
254 using KT on neuromuscular performance in the athlete population, especially females.

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Figure captions:

Figure 1. Study flow chart.

Figure 2. Kinesio taping applications: gastrocnemius (GT), biceps femoris (BF), vastus lateralis (VL), vastus medialis (VM), rectus femoris (RF), gluteus medius (Gmed) muscles.

Figure 3. Tuck jump assessment scoring frequencies for (A) KT 0, (B) KT 50, and (C) KT75 groups.

Figure 3 A. Tuck jump assessment scoring frequencies for KT 0 group.

Figure 3 B. Tuck jump assessment scoring frequencies for KT 50 group.

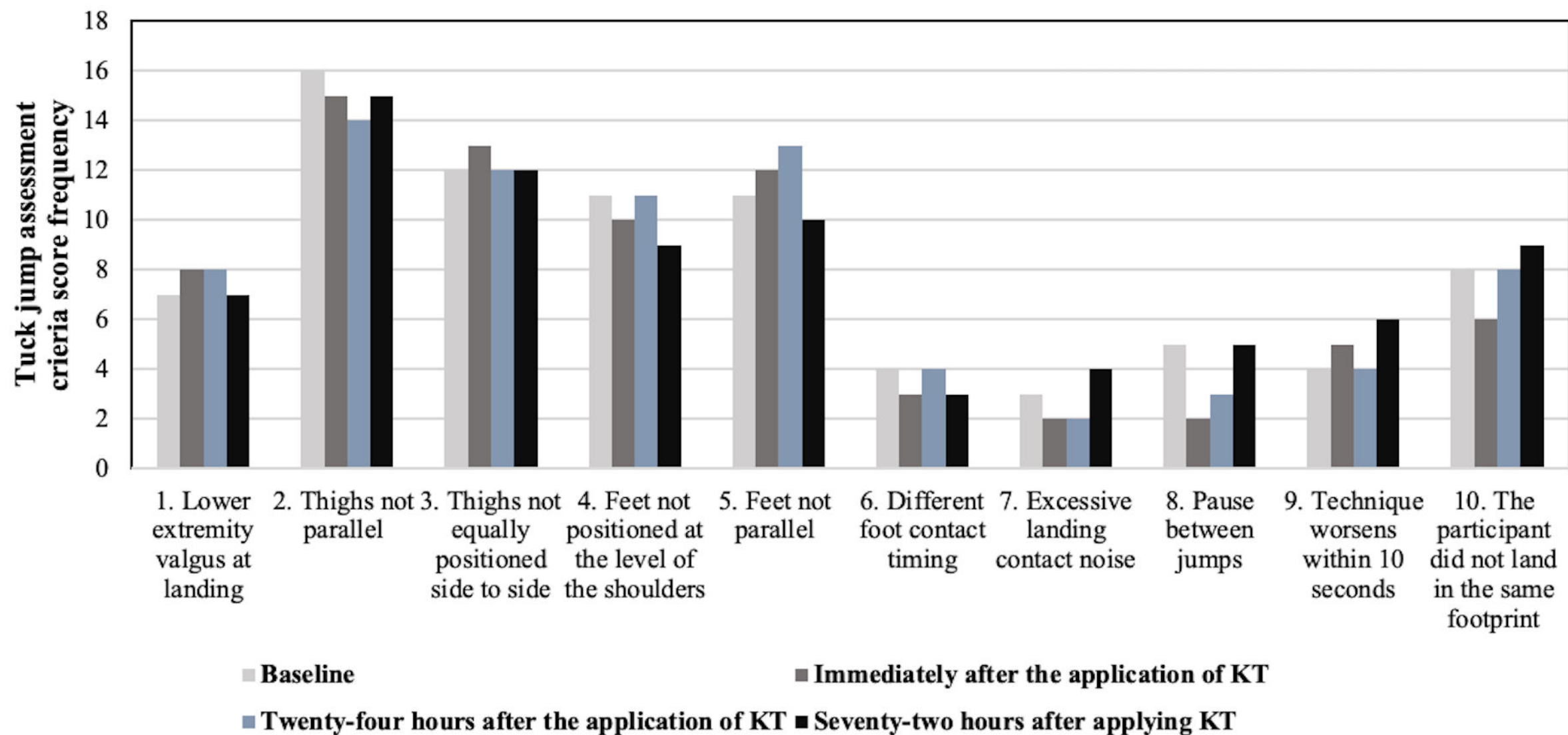
Figure 3 C. Tuck jump assessment scoring frequencies for KT 75 group.

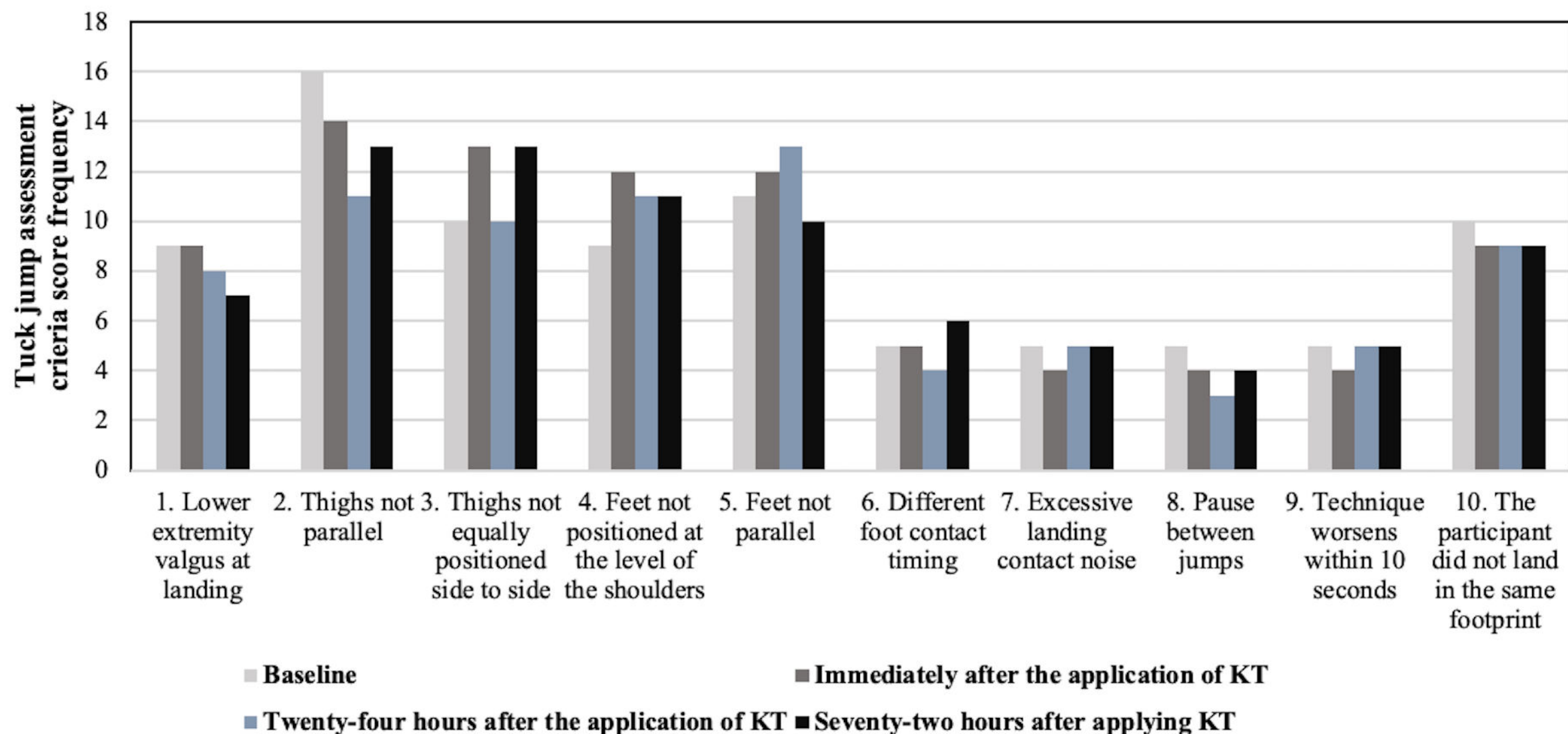
Tables captions:

Table 1. The identifiable flaws during tuck jump assessment [2, 4].

Table 2. Mean (SD) age, height, and mass of the three groups evaluated.

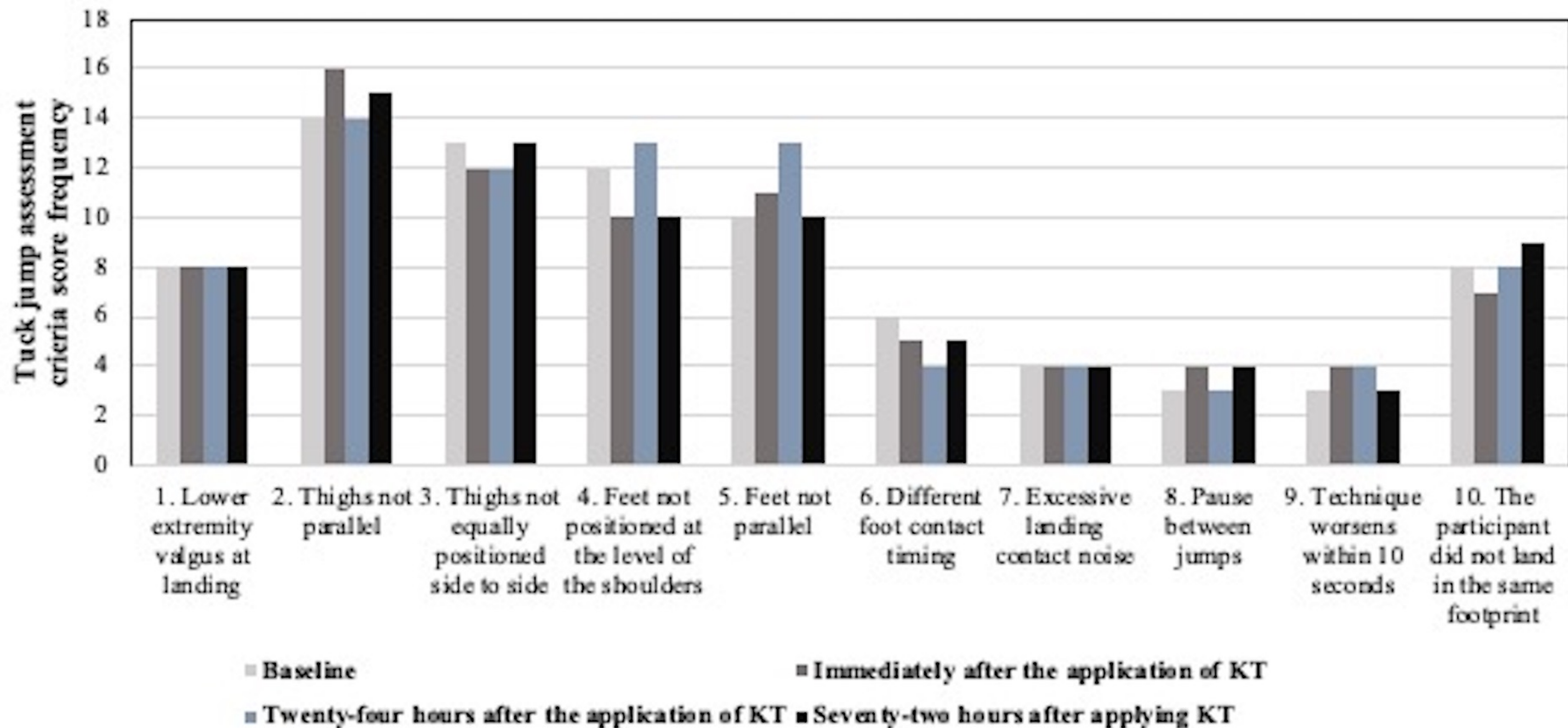
Table 3. Neuromuscular performance (tuck jump assessment) differences between the “KT 0”, “KT 50” and “KT 75” group.

A**Tuck jump assessment scoring frequencies for KT 0 group**

B**Tuck jump assessment scoring frequencies for KT 50 group**

C

Tuck jump assessment scoring frequencies for KT 75 group



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Table 1. The identifiable flaws during tuck jump assessment [12, 13].

Flaws during tuck jump assessment	Score
(1) Lower extremity valgus at landing	
(2) Thighs not parallel (peak of jump)	
(3) Thighs not equally positioned side to side (during flight)	
(4) Feet not positioned at the level of the shoulders	
(5) Feet not parallel (front to back)	
(6) Different foot contact timing (asymmetrical landing)	
(7) Excessive landing contact noise	
(8) Pause between jumps	
(9) Technique worsens within 10 seconds	
(10) The participant did not land in the same footprint (excessive in-flight motion).	
Total Score	

Table 2. Mean (SD) age, height, and mass of the three groups evaluated.

Characteristic	KT0 (n = 22)	KT50 (n = 23)	KT75 (n = 23)	<i>p</i> -value [†]
Age (year)	23.59 ± 1.99	22.70 ± 2.54	22.78 ± 2.11	0.34
Height (cm)	179.77 ± 8.84	177.87 ± 8.29	177.48 ± 7.37	0.61
Mass (kg)	74.05 ± 5.67	72.80 ± 7.28	70.63 ± 6.49	0.21
BMI (kg/m ²)	22.93 ± 1.15	23.02 ± 1.76	22.41 ± 1.32	0.31
Training experience (year)	7.05 ± 2.89	7.83 ± 2.62	7.61 ± 3.09	0.65
Training (h/wk)	8.45 ± 2.63	7.09 ± 2.35	8.17 ± 1.97	0.12

Abbreviation: KT, Kinesio taping; KT0, Kinesio taping without tension; KT50, 50% tension applied to the Kinesio taping; KT75, 75% tension applied to the Kinesio taping; †, *p*-value of ANOVA; cm, centimeter; kg, kilogram; SD, standard deviation; m, meter; h, hours; wk, week

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19 **Table 3.** Neuromuscular performance (tuck jump assessment) differences between the “KT 0”, “KT 50” and “KT 75” group.

Tuck jump assessment	KT 0	KT 50	KT 75	“KT 0” vs “KT 50” group differences: effect size (95%CI) and P value	“KT 0” vs “KT 75” group differences: effect size (95%CI) and P value	“KT 50” vs “KT 75” group differences: effect size (95%CI) and P value	Group		Time		Group × time Interaction Effect	
							F Score	P-value	F Score	P-value	F Score	P-value
Baseline	4.59 ± 1.10	4.22 ± 1.13	3.96 ± 0.98	NA (-0.26 to 0.92) <i>p</i> = 0.74	NA (0.004 to 1.20) <i>p</i> = 0.15	NA (-0.34 to 0.82) <i>p</i> = 0.99	5.36	0.007	2.6	0.06	0.08	0.99
Immediately after the application of KT	4.36 ± 0.79	4.09 ± 0.90	3.83 ± 0.72	0.31 (-0.27 to 0.90) <i>p</i> = 0.76	0.69 (0.10 to 1.30) <i>p</i> = 0.09	0.31 (-0.26 to 0.90) <i>p</i> = 0.83						
Twenty-four hours after the application of KT	4.23 ± 1.15	3.91 ± 0.79	3.61 ± 0.89	0.32 (-0.26 to 0.91) <i>p</i> = 0.82	0.59 (0.003 to 1.20) <i>p</i> = 0.10	0.35 (-0.23 to 0.94) <i>p</i> = 0.85						
Seventy-two hours after applying KT	4.09 ± 0.81	3.87 ± 0.76	3.65 ± 0.71	0.28 (-0.31 to 0.87) <i>p</i> = 0.99	0.57 (-0.02 to 1.17) <i>p</i> = 0.17	0.29 (-0.28 to 0.88) <i>p</i> = 0.99						

20 **Abbreviation:** KT, Kinesio taping; KT0, Kinesio taping without tension; KT50, 50% tension applied to the Kinesio taping; KT75, 75% tension
21 applied to the Kinesio taping; 95% CI, 95% confidence interval.

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