

# A Comparative Laboratory Study of the Tensile Stiffness and Peel Strengths of Four Commercial Kinesiology Tapes

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**ABSTRACT:** Kinesiology tapes were selected for two functions in athletic care: providing mechanical support via the backing, and maintaining secure but removable attachment via adhesive peel strength. This study compared four tapes: Kinesio, KT, Decathlon, and an unbranded product, to identify which product best satisfied these factors. Tensile behavior was quantified by stress-strain testing of a section of tape specimen in the longitudinal direction, with linear regression of the elastic region to obtain effective Young's modulus. Adhesive performance was assessed using a 90° peel test on a silicon substrate with tape specimens under dry and wet conditions. Steady-state peel loads were recorded and normalized by specimen width. Bench testing used a calibrated force gauge and manual pull rate. The Kinesio tape had the highest Young's modulus, while the Unbranded tape had the lowest. The Unbranded tape had the highest dry peel strength, while the KT tape had the lowest. Wet peel strength decreased for every brand. Kinesio provides the highest backing stiffness and thus the greatest restoring force, being best for mechanical support. The Unbranded tape exhibits the strongest adhesion in both wet and dry conditions.

**KEYWORDS:** Biomedical Engineering, Rehabilitation Engineering, Young's Modulus, Peel Strength, Kinesiology Tape.

## ■ Introduction

In a study on university-level athletes, the prevalence of athletes with injuries was 91%, meaning that in a study with 81 athletes, only 7 athletes reported having no injuries. A total of 185 musculoskeletal injuries were reported, with an average of 2.28 injuries per athlete.<sup>1</sup> In athletes' recovery journeys for their sports-related injuries, they would use kinesiology tape for a range of reasons. In a study conducted with 200 students, 133 (67%) reported the usage of Kinesiology tape, with 121 (61%) of them applying the tape as a measure in dealing with musculoskeletal problems.<sup>2</sup> Kinesiology tape, or more commonly referred to as sports tape, is an elastic tape widely used in sports medicine and rehabilitation to provide adjunctive support for musculoskeletal injuries and to manage symptoms such as pain and swelling.<sup>3</sup>

These tapes are manufactured from an elastic fabric backing and a medical-grade, pressure-sensitive adhesive. The fabric of the tape can be stretched during application and subsequently would have a restorative force as it attempts to retract to its original length, which has been proposed to contribute to mechanical support.<sup>4</sup>

However, after trying a range of brands myself due to multiple ligament tears, I found out that there are limitations in all these brands, with each of them falling short in different departments. Some of the brands have an adhesive that is too sticky, to the point that it causes some tearing of the skin or red marks after removal. Some brands might be lacking in the bandage part of the tape, with it not having a strong enough tensile strength or not having a strong enough restoring factor for the tape to be effective.

Because commercial tapes differ in their fabric materials, weave, and adhesive formulation, a quantitative comparison that measures both the tensile behavior and peel adhesion is able to better inform consumers and athletes when selecting a tape for a given application. This study, therefore, compares four different brands of sports tape, Kinesio®, KT Tape®, Tarmak (Decathlon store brand), and an unbranded tape, using standardized mechanical metrics. More specifically, the tapes used are the Kinesio® Tex Classic (UPC: 850989002386), KT Tape® Original Cotton (UPC: 893169002813), Decathlon Tarmak Kinesiology Support Tape - Beige (Reference: 8596815), and the Unbranded tape (EAN: 5014749120696). The testing methods used will be a tensile restoring force test, used to derive the stress-strain behavior of the tape fabrics, and the 90° peel test on dry and wet substrates to mimic sweating, used to obtain the peel strength of adhesives.

However, due to the lack of professional testing equipment like a peel test machine, hand testing by pulling a force gauge introduces possible variability in displacement rate, alignment, and load application continuity. Additionally, due to ethical issues, the experiments will be done on a skin substitute, and while it may replicate most aspects and characteristics of human skin, it will not be a one-to-one replacement.

## ■ Literature Review

Kinesiology tape is frequently applied in clinical and athletic settings as an adjunct for pain control, proprioceptive facilitation, and functional support.<sup>4</sup> Systematic and randomized trials report mixed but sometimes favorable short-term effects on pain, range of motion, and perceived function in some pa-

tient groups, although the magnitude and consistency of these effects vary by condition and methodology.<sup>5</sup>

Kinesiology tapes are engineered for high elasticity, typically woven from cotton and elastic yarn, such as spandex,<sup>6</sup> which yields a soft, stretchy mesh that mimics the skin's tensile properties. For example, Kinesio® tape is advertised as 100% cotton with elastic fibers, allowing it to stretch up to 120% to 140% of its resting length, recoiling back to its original length when tension is released.<sup>7</sup> The material composition of the Tarmak tape is 97% cotton 3% elastane; that of the KT Tape® is 100% cotton, and lastly, the composition of the unbranded tape is 95% cotton 5% spandex.

The large stretch range enables the tape to exert a significant restoring force when stretched during application or movement, and can serve as an “external ligament”, providing mechanical support, naturally going back to its original position to take the burden off an athlete's ligaments.<sup>8</sup> So, the elasticity of sports tape, quantified through its Young's modulus ( $E$ ), the ratio of tensile stress to strain, would affect the mechanical support it provides.<sup>9</sup> The Young's modulus is the property of a material that dictates how easily it stretches and deforms, and is calculated through the equation  $E = \sigma / \epsilon$ , where  $\sigma = F/A$  and  $\epsilon = \Delta L / L_0$ , where  $F$  is the force applied,  $A$  is the cross-sectional area of the tape,  $\Delta L$  is the change in length, and  $L_0$  is the initial length of the tape. Young's modulus is thus obtained from the gradient of a stress-strain graph and has the units  $Pa$ .<sup>9</sup> It is a physical quantity describing the ability of a solid material to resist deformation. The larger the value, the more force is required to deform the material.<sup>10</sup>

A tape with higher  $E$  will require more force to be elongated the same amount, therefore exhibiting a greater resisting force per unit elongation, increasing its capacity to resist joint translation and rotation when applied across a joint. The tape will thus be able to bear more external load and contribute greater resisting force across a taped joint, able to “share” load with injured ligaments or tissues rather than allowing that load to be taken entirely by the damaged structure.<sup>11</sup> So, taping can reduce injurious joint excursions and improve joint-repositioning accuracy, mechanisms by which stiffer external tape can help off-load injured ligaments and limit excessive motion.<sup>11</sup> Conversely, some tapes lack sufficient elasticity or tensile strength, so they exert less recoil and provide limited mechanical support.

Laboratory tests confirm that tape brands differ in tensile performance, with Kinesio® tape showing superior values in 3 out of 4 tensile metrics when compared to other tapes.<sup>12</sup> This thus proves how some brands of tape have higher tensile strength, being able to withstand greater load, as well as having a stronger restorative force and Young's modulus. So, different brands of tape would be expected to have varying levels of effectiveness in the support they provide. However, it is important to note that tape support is not static and that under repeated loading caused by factors like exercise, the tape loses elasticity. In fatigue tests of sports tapes, all specimens showed increased stiffness after cyclic loading. For example,<sup>20</sup> minutes of simulated use reduced support by 21% to 57% and made the tape up to 20% stiffer. So, these findings underscore

that both the initial tensile properties and fatigue behavior of the tape material are relevant to how well it supports an athlete during prolonged activity. However, this study will only investigate the initial tensile properties of the different tapes.<sup>13</sup>

As for the adhesive of the tape, manufacturers coat the tape with a medical-grade acrylic adhesive, typically latex-free and hypoallergenic, so it sticks securely yet can be worn for several days.<sup>6</sup> For example, Kinesio® tape's adhesive is heat-activated and designed to stick firmly under tension, while remaining safe for sensitive skin.<sup>6</sup> This adhesive is usually applied on the tape in a patterned manner, allowing moisture to escape, permitting multi-day wear even during sweating. Manufacturers like Kinesio® claim that the tape will stay on through showering or exercise, simply drying quickly when wet.<sup>7</sup>

To test for the adhesive strength of the sports tapes, the peel test was used. The 90° peel test is a standardized method used to evaluate the peel resistance, or peel test, of an adhesive bond between a flexible adherent, like the sports tape, and a rigid substrate, where the flexible part is pulled perpendicular, or at a 90° angle, to the substrate surface.<sup>14</sup> The flexible tape is pulled upward at a constant speed, maintaining the 90° angle throughout, allowing for a steady-state plateau, in which the measured peel force becomes approximately constant with continued peeling.<sup>15</sup> This plateau is the region used to characterize the adhesive's practical peeling resistance. This setup enables measurement of the force needed to separate the bond under controlled conditions.<sup>14</sup> The peel force is then divided by the width of the bonded pad to obtain peel strength, which is the average force per unit width to separate a bonded adhesive,<sup>16</sup> to obtain a normalized property of the adhesive, which can then be compared to other adhesives.

The measured peel strength of sports tape adhesives varies by brand and condition. In standardized peel tests on dry and wet skin, the peak adhesive force has been reported to reduce adhesive grip by over half when applied on wet skin, as compared to dry skin.

Clinically, an adhesive on sports tape must strike a balance, resisting the movements and sweat of an athlete yet releasing without undue pain. If the peel strength is too high, removing the tape can cause skin injury. Medical adhesives with excessive adhesion are known to cause “skin tripping” and tears during removal, or even strip off layers of the skin or produce blisters, a known form of medical adhesive-related injury.<sup>17</sup> Conversely, if the adhesive is too weak, the tape will peel off prematurely and will not be secured when an athlete moves. Thus, the ideal tape adhesive provides moderate peel strength, strong enough to stay on through activity, but not so strong that it leaves the user with bruises or skin tears.

As research shows, there is a general trend of increasing pain with increasing peel force, and as such, the lower the peel force, the less pain experienced when the sports tape is removed.<sup>18</sup> The medical-adhesive review recommends a peel strength of 0.4–2  $Ncm^{-1}$  for excellent removability, balancing secure attachment and painless removal.<sup>19</sup> As such, the ideal adhesive of a sports tape is to have a peel strength of 0.4–2  $Ncm^{-1}$ , both on wet and dry surfaces, to ensure a painless removal while still keeping a secure attachment to the user's skin.

## ■ Methods

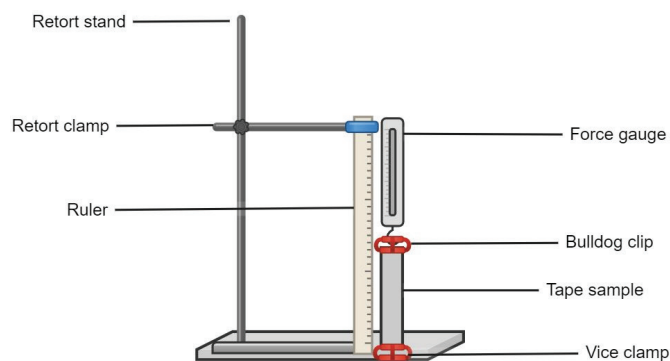


**Figure 1:** Set-up to test for the elasticity of tape samples (original image).

In this study, uniform strips of sports tape, 15.0 cm in length, and 5.0 cm in width and 0.05 cm in thickness, were prepared. These strips were kept in the same environment to ensure consistent adhesive behavior, minimizing variability and environmental impacts on their tensile behavior, ensuring that as many variables as possible are kept controlled to enhance accuracy. Each piece was then secured at one end using a vice clamp, firmly holding the tape in place, so that only a 10 cm section of the tape was exposed to testing (Figure 1). The opposite end was gripped by a bulldog clip attached to a calibrated force gauge. Next, a retort stand was placed beside the vice-clamp set-up, with a ruler being secured vertically next to the tape. This was to act as a vertical displacement scale, providing direct visual confirmation of the tape's vertical displacement and elongation when loaded and stretched. Thus, this set-up was used to measure the respective forces needed to elongate the tape by specific lengths, determining the tape's tensile characteristics.

Before each test, the force gauge was zeroed to ensure that there was no zero error, ensuring accurate readings. Tensile loading was applied to the tape by pulling up vertically on the force gauge to stretch the tape in the longitudinal direction to specified lengths, from 0 to 8 cm in 2 cm increments. The force reading was then recorded once stabilized, thereby capturing discrete data points that reflect the tape's elastic properties. Throughout testing, care was taken to maintain consistent clamp alignment, preventing slippage of the tape that could affect the accuracy of the stress-strain response.

The raw measurements of force  $F$  and elongation  $\Delta L$  were then processed into engineering stress  $\sigma$  and strain  $\epsilon$ , where  $\sigma = F/A$  and  $\epsilon = \Delta L / L_0$ , where  $A$  is the cross-sectional area of the tape and  $L_0$  is the initial length of the tape. Then,  $\sigma$  was plotted against  $\epsilon$  to obtain a stress-strain curve, which was used to determine Young's modulus.

To increase the precision of results and to account for the impact of random errors, 5 replicates were tested for each data point of each tape type to ensure statistical validity. Each replicate was carried out with a new piece of tape. The results were then reported as *mean  $\pm$  standard deviation*, where error bars on the plotted graph represent the standard deviation of the data points.

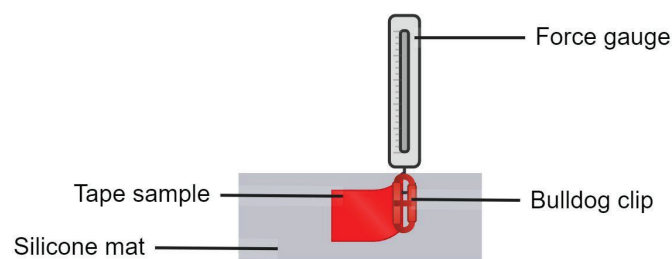


**Figure 2:** Set-up to test the peel strength of tape samples (original image).

To test for the peel strength of the adhesive on the different tapes, the tapes were cut into uniform rectangles, 5 cm in width and 7 cm in length. They were kept in the same environment to ensure consistent adhesive behavior, minimizing the discrepancy that temperature and humidity would cause between different tape samples.

A silicone mat was chosen as the test surface for the adhesives, due to its similar surface properties to human skin. The mat was cleaned with isopropyl alcohol and allowed to dry before testing, to ensure that there would be no surface contaminants that would bias results, improving repeatability and comparability between results.

A bulldog clip was attached to one end of the tape, so that the exposed area of the tape is 5 cm by 5 cm. This square area is then laid onto the silicone mat, smoothed with a single uniform pass of a flat-edged roller, and then left for a 10 s dwell time. A calibrated force gauge is then attached to the bulldog clip to measure the force required to peel the tapes (Figure 2). The specimen width was noted and later used to normalize the peel load to per-unit-width peel strength. Consistent application conditions, like pressure and dwell time, are essential as peel force is highly sensitive to initial contact conditions and effective bonded width. Thus, keeping the application conditions constant ensured that conditions were kept as similar as possible between samples, to reduce the impact of systematic error.

A 90° peel angle was established by using a set square that followed the edge of the tape as it was peeled. The set square was used as a calibration to ensure that the angle between the surface of the tape applied to the mat and the force gauge was being pulled to peel the tape off at a 90° angle. Before each test, the force gauge was zeroed and checked with a small known load to confirm calibration. Although laboratory-grade peel testers maintain exact kinematics, the manual arrangement described here follows the same geometry principles used in standardized 90° tests.

The peeling was also maintained at a controlled rate of 1.0 mm/s, and was maintained through the use of a ruler and a stopwatch, ensuring that 10 mm of tape was peeled. The force gauge then measured the constant force needed to peel the tape as the peel rate was kept constant. The peel rate was kept constant to ensure that the force required to peel the tape remains constant throughout the testing of one specimen. This is the steady-state peel region, which gives the most representative measure of adhesive peel strength, which was then normalized by specimen width to report peel strength.

The adhesive strength was also tested on a wet surface, which aimed to investigate the adhesive properties under conditions of a sweaty skin surface. The silicone mat was dosed with 0.3 ml of deionized water, applied by spray from a distance of 5 cm away, to an area of 5 cm by 5 cm, immediately before the tape application. The same application conditions, such as pressure, dwell time, peel angle, peel rate, and data-logging procedure, were kept. The steady-state peel force was then recorded to investigate the effect of surface moisture, such as sweat, on adhesive performance.

Data processing was performed by normalizing the load by specimen width to obtain peel strength using the formula  $p = F/w$ , where  $p$  is the peel strength,  $F$  is the peel force, and  $w$  is the width of the tape sample. The peel strengths of the tapes were plotted against the brands to obtain a figure of comparison.

Five replicates were tested for each specimen under both dry and wet conditions, while maintaining all test variables constant, to enhance the precision of the results and minimize the impact of random errors. The results were reported as *mean ± standard deviation*, where error bars represent the standard deviation of the data points.

A one-way analysis of variance (ANOVA) test was then conducted separately for the peel strengths in both dry and wet conditions, in order to statistically compare the mechanical properties across the four tape brands. This was to confirm that the differences in mechanical properties were not due to random variation. Where significant differences were found, post hoc comparisons were performed using Tukey's HSD test to identify differences between specific brands. Statistical significance was set at  $p < 0.05$ . However, the one-way ANOVA test was not possible for the Young's moduli of the tapes, due to a grouped data analysis being carried out to determine the Young's modulus of each tape. The average stress values of all five samples were found at specific strain points, and the average stress against average strain graph was plotted. Thus, a singular average Young's modulus value was found through the slope of this single, combined line. Since there was not one Young's modulus value for each replicate of each brand, but instead only one average value for each brand, the conditions required for an ANOVA test to be conducted were therefore not met.

## ■ Results and Discussion

### Results:

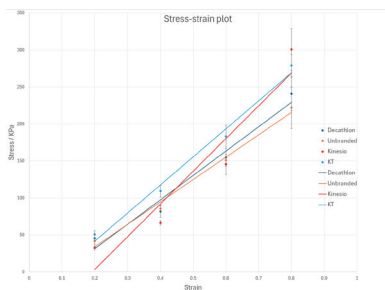


**Figure 3:** Linear regression of the stress-strain data, showing the elastic region of stress-strain curves. Kinesio tape had the steepest gradient, indicating Young's modulus was the greatest.

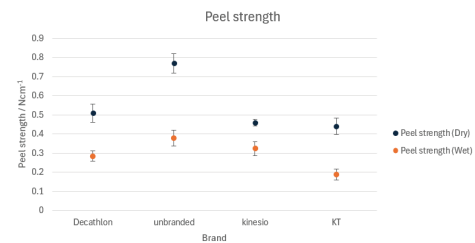


**Figure 4:** Peel the strengths of the respective brands of athletic tape. Dry peel strength was higher than wet, with the unbranded tape showing the highest values.

**Table 1:** Values of Young's Modulus. Kinesio's was the highest.

| Brand     | Young's modulus / $KPa$ | $R^2$  |
|-----------|-------------------------|--------|
| Decathlon | 329.59                  | 0.9714 |
| Unbranded | 302.96                  | 0.9893 |
| Kinesio   | 442.19                  | 0.9124 |
| KT        | 379.46                  | 0.9881 |

**Table 2:** Values of dry and wet peel strength. The unbranded tape had the highest values for both wet and dry conditions.

| Brand     | dry peel strength / $Ncm^{-1}$ | wet peel strength / $Ncm^{-1}$ |
|-----------|--------------------------------|--------------------------------|
| Decathlon | $0.51 \pm 0.05$                | $0.28 \pm 0.03$                |
| unbranded | $0.77 \pm 0.05$                | $0.38 \pm 0.04$                |
| kinesio   | $0.46 \pm 0.02$                | $0.32 \pm 0.04$                |
| KT        | $0.44 \pm 0.04$                | $0.19 \pm 0.03$                |

The produced gradient of the linear regression of the stress-strain data is taken as the elastic moduli, or Young's modulus values, that differed across brands (Figure 3). These regression lines exhibited strong goodness-of-fit from the high  $R^2$  values. In order from the highest to lowest Young's modulus values, Kinesio brand tape showed the highest modulus (442.19  $kPa$ ;  $R^2 = 0.9124$ ), followed by KT (379.46  $kPa$ ;  $R^2 = 0.9881$ ), then Decathlon, (329.59  $kPa$ ;  $R^2 = 0.9714$ ), and lastly the unbranded product (302.96  $kPa$ ;  $R^2 = 0.9893$ ) (Table 1). These fits explained more than 91% of the variance in measured stress over the tested strain range, thus supporting the use of the gradient of the linear regression models as a single effective modulus to compare backing stiffness between brands.

The peel testing also yielded distinct adhesion profiles in dry and wet conditions, and the values were plotted (Figure 4). Under dry conditions, the mean normalized peel strengths were, in order of highest to lowest, Unbranded ( $0.77 \pm 0.05 Ncm^{-1}$ ), Decathlon ( $0.51 \pm 0.05 Ncm^{-1}$ ), Kinesio ( $0.46 \pm 0.02 Ncm^{-1}$ ) and KT ( $0.44 \pm 0.04 Ncm^{-1}$ ). Through the one-way ANOVA test, it was determined that  $F(3,16)=53.4$ , and  $p=1.48 \times 10^{-8}$ , thus revealing a significant effect of tape brand on peel strength. Post hoc comparisons using Tukey's HSD test then showed that the unbranded tape had significantly higher peel strength than all other brands.

Wet substrate testing produced lower values for every brand, with the mean normalized peel strengths, from order of highest to lowest, being: Unbranded ( $0.38 \pm 0.04 Ncm^{-1}$ ), Kinesio

( $0.32 \pm 0.04 \text{ Ncm}^{-1}$ ), Decathlon ( $0.28 \pm 0.03 \text{ Ncm}^{-1}$ ) and KT ( $0.19 \pm 0.03 \text{ Ncm}^{-1}$ ). The percentage reductions in mean peel strength from dry to wet were, from highest to lowest, KT (57.4%), Unbranded (50.9%), Decathlon (44.5%) and Kinesio (29.8%) (Table 2). A one-way ANOVA test was carried out for the wet peel strength too, determining that  $F(3,16)=21.9$ , and  $p=6.57 \times 10^{-6}$ . Post hoc comparisons showed that the unbranded tape maintained a significantly higher peel strength than the KT and Decathlon tapes, while the differences in wet peel strength between the unbranded and Kinesio tapes were not statistically significant.

### Discussion:

The tensile results indicate meaningful differences in backing stiffness between brands that are likely to influence a tape's mechanical support in use. Kinesio tape's substantially larger effective Young's modulus of  $442.19 \text{ kPa}$  implies that, for a given percentage elongation, it will generate greater tensile stress and therefore larger restoring forces than the other products tested. Conversely, the unbranded tape with a Young's modulus of  $302.96 \text{ kPa}$  is the most compliant and will produce the least passive resistance to deformation under equivalent stretch. According to literature, since restoring force underlies a tape's passive mechanical contribution to restricting excessive joint movement, these data suggest that Kinesio tape is the strongest candidate when maximal passive support is required, providing the most mechanical support and stability when applied, while the unbranded and Decathlon tapes will allow a greater range of motion under comparable application tension.

The noticeable inter-brand differences in their Young's modulus observed are most likely explained by the differences in textile architecture, like fabric weave, rather than the differences in constituent materials. The fabric backing of kinesiology tapes is textiles, in which factors like yarn crimp and weave geometry determine how load is transferred from macro-scale extension into fiber elongation, so two tapes made from similar materials can exhibit substantially different stiffness if their weave, yarn twist, or interlacing density differ.<sup>20</sup> In woven fabric mechanics, the weave structure substantially influences tensile stiffness. For example, plain weaves generally exhibit higher stiffness and strength due to denser interlacings and reduced porosity, while alternative weaves may alter the fabric's Young's modulus due to increased float and crimp levels.<sup>21</sup> As such, due to the relative material composition of each sports tape, the performance variation between them can be attributed to factors like fabric weave.

Next, adhesive performance showed a clear ranking and an apparent sensitivity to moisture. In the dry state, the unbranded tape had the highest mean peel strength, substantially exceeding the other three brands, with Kinesio and KT having similar dry peel strengths. The one-way ANOVA test conducted confirmed that the differences in peel strengths were statistically significant, with post hoc comparisons further showing that the unbranded tape had significantly greater peel strength than all other brands. Therefore, the unbranded tape demonstrated the strongest adhesive performance under dry conditions. Since the ideal adhesive of a sports tape is to have

a peel strength of  $0.4\text{--}2 \text{ Ncm}^{-1}$  to ensure a painless removal while still keeping a secure attachment on the user's skin, and all brands tested have a peel strength below the upper limit of  $2 \text{ Ncm}^{-1}$ , this means that the tape with the best adhesive would be the Unbranded tape, with the strongest peel strength of  $0.77 \text{ Ncm}^{-1}$ .

However, exposure to a wet substrate reduced peel forces for every brand and altered the practical adhesion ranking in terms of in-use reliability. Although the unbranded tape retained the highest absolute wet peel load, its adhesion was reduced by 50.9%, and KT lost the largest percentage of adhesion, 57.4%. This leaves KT with the weakest wet adhesion with a wet peel strength of  $0.19 \text{ Ncm}^{-1}$ . Kinesio tape has the smallest reduction in peel strength from dry to wet of 30%, suggesting the greatest retention of adhesive function in moist conditions compared with the other tapes tested. In wet conditions, the unbranded tape still maintained the highest mean peel strength, with the one-way ANOVA test indicating that tape brand remained a significant factor affecting peel strength. Post hoc comparisons showed that statistically, the unbranded tape maintained significantly higher adhesion than KT and Decathlon, while differences between the unbranded and Kinesio were not statistically significant. Out of all 4 brands, only the Unbranded tape's wet peel strength lies within the range of  $0.4\text{--}2 \text{ Ncm}^{-1}$  that literature provided to ensure secure attachment, and as such, it is the best tape in terms of its adhesive strength, in both dry and wet environments.

### ■ Conclusion

The findings above have practical implications: clinicians and athletes should match tape selection to the intended function and conditions of use. If the priority is to provide maximum joint support, a high-modulus backing is preferable, and as such, Kinesio offers the best tape that provides the most mechanical support. If strong fixation in dry conditions is essential, a high-adhesion product like the

Unbranded tape is the best choice. Importantly, the substantial wet-state reductions observed here underscore the necessity of testing adhesives under conditions that mimic real use rather than relying on dry-state data alone. Thus, taking into account both the wet and dry peel strengths, the Unbranded tape has the strongest peel strength in both tests, and as such is the best tape to ensure a painless removal while still keeping a secure attachment on the user's skin. However, these recommendations should be interpreted in the context of the reported values and the study's laboratory conditions. Clinicians selecting tape should also weigh user comfort, skin sensitivity, and the specific demands of the sporting activity.

Limitations of this study include the modest sample sizes and the controlled bench protocol that cannot capture all *in vivo* variables like anatomical site, skin condition, motion patterns, and repeated application cycles. Additionally, peel and tensile behavior depend on test geometry and rate; thus, absolute values will vary with protocol. This is largely due to the limitations of manual testing. Using a handheld force gauge and manually pulling introduces variability in displacement rate, alignment, and load application continuity.

As such, an improvement would be to use Universal testing machines, which, by contrast, offer precisely controlled crosshead speed, axial alignment, and feedback, which enhance accuracy and repeatability in modulus and peel measurements. Future work should expand, replicating numbers, include cyclic fatigue testing of backing elasticity, and perform in-vivo retention and skin-comfort assessments to link these bench metrics with functional and clinical outcomes. Additionally, while the inter-brand ranking by stiffness and adhesion in this study is informative and well-supported, the absolute modulus and peel strength values should be interpreted with caution and ideally re-validated using standardized, machine-controlled protocols.

## ■ AI Acknowledgments

During the preparation of this work, the author(s) used no AI tools.

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I attest that the ideas, graphics, and writing in this paper are entirely my own. The author would also like to thank Rosalyn Abbott for her guidance and mentorship throughout the process of writing this research.

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