Original article

Effect of Achilles Tendon taping on parameters of gait in asymptomatic-overweight and obese individuals

Efeito do taping no Tendão de Aquiles nos parâmetros da marcha em indivíduos assintomáticos obesos e acima do peso

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ABSTRACT | INTRODUCTION: Overweight and obesity affect gait variables such as cadence, step length, stride length, and Achilles tendon deterioration. Rigid Achilles tendon Taping reduces stress and enhances joint stability and can be employed as external support during gait training to modify gait parameters. **OBJECTIVE:** To find out whether taping modifies gait patterns with increasing weight. **METHODS AND MATERIALS:** 40 subjects were recruited (20 overweight and 20 obese) whose step length, stride length, and cadence were measured before and after rigid Achilles tendon taping. Each person completed the 10-meter walk test using Gait Analyzer application. **RESULTS:** The Shapiro-Wilk test is used to assess the normality of the data. Wilcoxon Signed Rank Test is used for within-group differences. Within-group differences were significant in gait parameters $p<0.05$ (Step length $p<0.001$, Stride length $p<0.001$ and cadence $p=0.009$). **CONCLUSION:** Rigid Achilles tendon taping have a similar effect on gait parameters in overweight and obese individuals. After taping, there was a significant difference in terms of stride length, step length and cadence in the study population before and after Achilles taping. This implies that regardless of body weight, the tape intervention affects gait mechanics in a comparable way and is intended to prevent excessive joint motion, provide proprioceptive input during activities, and lessen discomfort.

KEYWORDS: Achilles Tendon. Adult. Body Mass Index. Obesity. Overweight.

RESUMO | INTRODUÇÃO: Sobrepeso e obesidade afetam variáveis de marcha tais como cadência, comprimento do degrau e comprimento dos passos junto com a deterioração do tendão de Aquiles. A rígida rosca do tendão de Aquiles reduz a tensão e aumenta a estabilidade da articulação e pode ser empregada como suporte externo durante o treinamento da marcha para modificar os parâmetros da marcha. **OBJETIVO:** Descobrir se o taping modifica os padrões de marcha com o aumento do peso. **MÉTODOS E MATERIAIS:** Foram recrutados 40 sujeitos (20 acima do peso e 20 obesos) cujo comprimento dos degraus, comprimento dos passos e cadência foram medidos antes e depois da fita rígida do tendão de Aquiles. Cada pessoa completou o teste de caminhada de 10 metros usando o aplicativo Gait Analyzer. **RESULTADOS:** O teste Shapiro-Wilk é usado para avaliar a normalidade dos dados. O Wilcoxon Signed Rank Test e o Mann-Whitney U Test são usados para diferenças dentro e entre grupos. As diferenças dentro do grupo foram significativas nos parâmetros de marcha $p<0,05$ (Passo comprimento $p<0,001$, Stride comprimento $p<0,001$ e cadência $p=0,009$). Os parâmetros de marcha não diferiram estatisticamente entre os grupos. **CONCLUSÃO:** A aplicação de fita rígida no tendão de Aquiles tem um efeito semelhante nos parâmetros da marcha em indivíduos com excesso de peso e obesos. Após a aplicação da fita adesiva, verificou-se uma diferença significativa em termos de comprimento da passada, comprimento do passo e cadência na população estudada antes e depois da aplicação da fita adesiva para Aquiles. Isto implica que, independentemente do peso corporal, a intervenção com fita adesiva afeta a mecânica da marcha de forma comparável e destina-se a evitar movimentos articulares excessivos, a fornecer informações proprioceptivas durante as atividades e a diminuir o desconforto.

PALAVRAS-CHAVE: Tendão de Aquiles. Adulto. Índice de Massa Corporal. Obesidade. Sobrepeso.

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1. Introduction

Gait is a complex physical process that involves the coordination of muscles, bones, joints and ligaments and is used to identify, diagnose and treat a variety of medical conditions. It is an important factor when it comes to physical therapy, as it helps assess the limitations of an individual's movement.[1] The Achilles tendon is a common source of pain and injury for obese and overweight individuals due to the increased strain placed on the tendon from carrying extra weight.[2] Overweight and obese individuals are more likely to experience gait abnormalities due to their increased body mass and increased load placed on their joints. These changes can lead to an increased risk of joint pain, injury, and other musculoskeletal disorders. A cross-sectional study compared gait parameters between overweight/obese and normal-weight individuals and found that overweight and obese individuals had a significantly slower walking speed, shorter step length, and reduced range of motion in the hip joint during walking. They also exhibited a wider stance width and greater variability in their step-to-step timing compared to the normal weight group.[3]

Changes in gait parameters can have a significant impact on the long-term health of overweight and obese individuals, such as the increased risk of Achilles tendinopathy and other musculoskeletal disorders due to increased load placed on the Achilles tendon during weight-bearing activities.[4] Recent research has shown obesity as a significant but potentially adjustable risk factor for various tendinopathies' development and progression.[5] Obesity can lead to altered biomechanics and an increased risk of musculoskeletal conditions due to changes in gait parameters, such as reduced ankle plantarflexion strength, altered ankle joint kinematics, and reduced knee joint flexion during walking.[6]

Taping as a treatment method provides reinforcement and stability to joints and structures surrounding it, which contributes to a decrease in tensile load reducing strain in the tendon during walking.[7] Different kinds of tapes and taping techniques are employed in the management of musculoskeletal pain and dysfunction. Rehabilitation professionals use elastic taping, such as Kinesio Taping, as a therapeutic intervention across programs and levels of care.

Either 100% cotton or a mixture of cotton and polyester with elastic material make up Kinesio Tape.[8] In sports or athletic tape, inelastic taping also known as hard strapping tape is frequently used to limit mobility and support anatomical structures.[9] Materials such as cotton, zinc oxide, or synthetic fibers are frequently used to make rigid tapes. Rigid tape typically contains a pressure-sensitive adhesive, or adhesive that sticks to surfaces when pressure is applied. The tape is coated with adhesive on one side and wrapped into a press-board tube for simple dispensing.[10] The amount and caliber of adhesive fluctuate, the paper-off stress varies across brands of elastic tape, and the elastic quality varies. Kinesio taping is used to treat edema, soft tissue injuries, misaligned joints and tissues, and more. In sports or athletic tape, inelastic taping — also known as hard strapping tape — is frequently used to limit mobility and support anatomical structures.[11] Smartphones are becoming popular for gait analysis due to their convenience and reliability, allowing clinicians to quickly and accurately measure a patient's gait parameters in real-time.[12] More clinical trials involving human subjects are needed to determine the parameters of gait after rigid Achilles tendon tape application. The objective of this study is to find out whether taping modifies gait patterns with increasing weight.

2. Methods and materials

This pre-test post-test experimental study design was used in this study. The study was conducted at the Department of Physiotherapy, Musculoskeletal Physiotherapy Laboratory, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India. The study was approved by the Institutional Ethical and Research Committee of Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India, reference number MMDU\IEC\2236. It was registered in the Clinical Trials Registry - India CTRI/2022/09/045201. The consent form is taken from the voluntary patients before the treatment. The patient is assured that there will be no harmful effects of the treatment on their health conditions, and the privacy of the patients will be maintained. This work is carried out in accordance with the Declaration of Helsinki.[13] Inclusion criteria are both males and females[14] in good health of the age

group 18-35 years[15], overweight with BMI > 25 to 29.9, obese with BMI > 30[16] and cognitive level sufficient to understand procedures and follow instructions. Exclusion criteria are individuals with neuropathic pain in the lower extremities, foot deformity, inability to apply ankle tape due[13] to the presence of a wound, ulcer, and skin damage, allergies to the therapeutic tape, leg length discrepancy (apparent and true), and subjects with a previous history of trauma /fracture past 6 months.[17] Participants were recruited from Maharishi Markandeshwar (Deemed to be University), Mullana. The sample size was calculated using G POWER[18] 3.1.9.7 the standard application for sample size calculation. In which the power of the study is estimated at 80%. The study included for the estimation of sample size has a 0.92 effect size obtained from pilot study[19], so by applying these values in G power software, the calculated sample size was 40 wherein 20 overweight and 20 obese population are included. Effect size is calculated with the formula Effect size=Mean post-Mean pre/SD pooled.

2.1 Procedure

The area to be taped is prepared primarily. After washing and drying the skin is shaved in a downward direction. Oils were eliminated for good adherence. Individuals are checked for any tape allergy. Regions of friction and pressure are covered with lubricated cushioning.

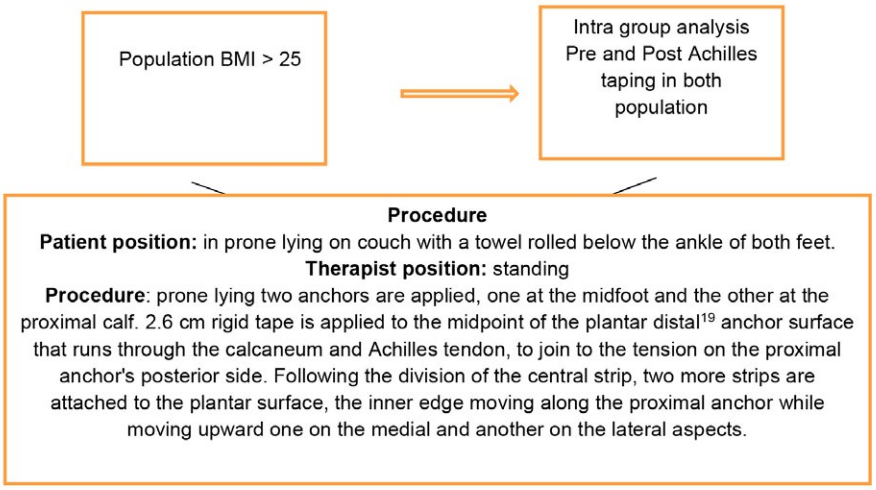
Position of subjects: prone lying two anchors are applied, one at the midfoot and other at the proximal calf. 2.6 cm rigid tape is applied to the midpoint of plantar distal anchor surface that runs through the calcaneum and Achilles tendon, to join to the tension on the proximal anchor's posterior side rigid tape is adhered to the skin in the heel region as demonstrated in Figure 1. Following the division of Strip 1, two more strips are attached to the plantar surface, the inner edge moving along the proximal anchor while moving upward one on the medial and lateral aspects, one in the center of strip 1 as in Figure 1. Following the division of central strip, two more strips are attached to the plantar surface, the inner edge moving along the proximal anchor while moving upward one on the medial and another on lateral aspects as in Figure 1.[20]

Figure 1. Taping of Achilles tendon[21]

Source: Macdoland R. (2010).[20]

Before and after Achilles tendon taping, subjects walked for 1 minute and 10 m using a gait analyzer application in a hallway where participants were verbally instructed to walk. This application is calibrated and provides gait parameters like step length, stride length and cadence.[21,22] Participants were verbally instructed.

Figure 2. Participants and Procedure of taping Achilles tendon



Source: the authors (2023).

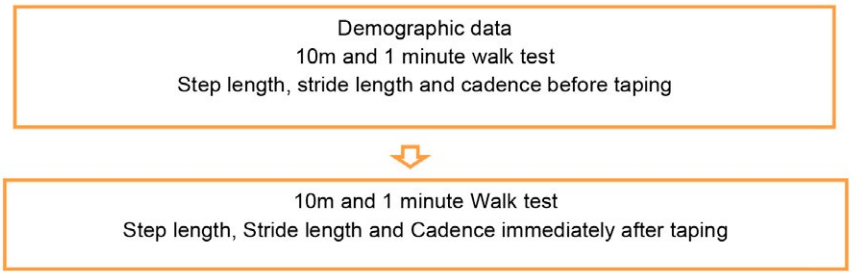
2.2 Outcomes variables

• Predictor variables: predictor variables is Rigid Taping of the Achilles tendon of both legs.

• Outcome variables: our outcomes variables include step length, stride length and cadence.[21]

The variables are measured before and after taping as shown in Figure 3.

Figure 3. Assessment before and immediately after taping Achilles tendon



Source: Silsupadol et al. (2017).[22]

Outcome measures: all outcomes were assessed at baseline and immediately after the intervention. The Gait Analyzer application was used for the measurement of gait parameters which have good validity and reliability. Here, outcome measures were taken using a 10-meter walk test and gait analyzer application.[21]

Step length: step length is measured on the line of progression[23] between the heel centers of two consecutive footprints by the same foot (left to left, right to right). The linear distance of approximately 15 inches along the line of progression of one foot is traveled during one gait cycle.

Stride length: the distance between two subsequent placements[24] of the same foot is known as the stride length which is normally 27 to 32 inches. There are two step lengths, left and right, and each one represents how far the specified foot advances in front of the other. The right step length will be zero if the left foot is brought up beside the right one as opposed to in front of it when taking a step forward with the left. If one foot never catches up to the other, the step length on that side may even be negative. Linear distance in the plane of progression between the successive points of foot-to-floor contact of the same foot.

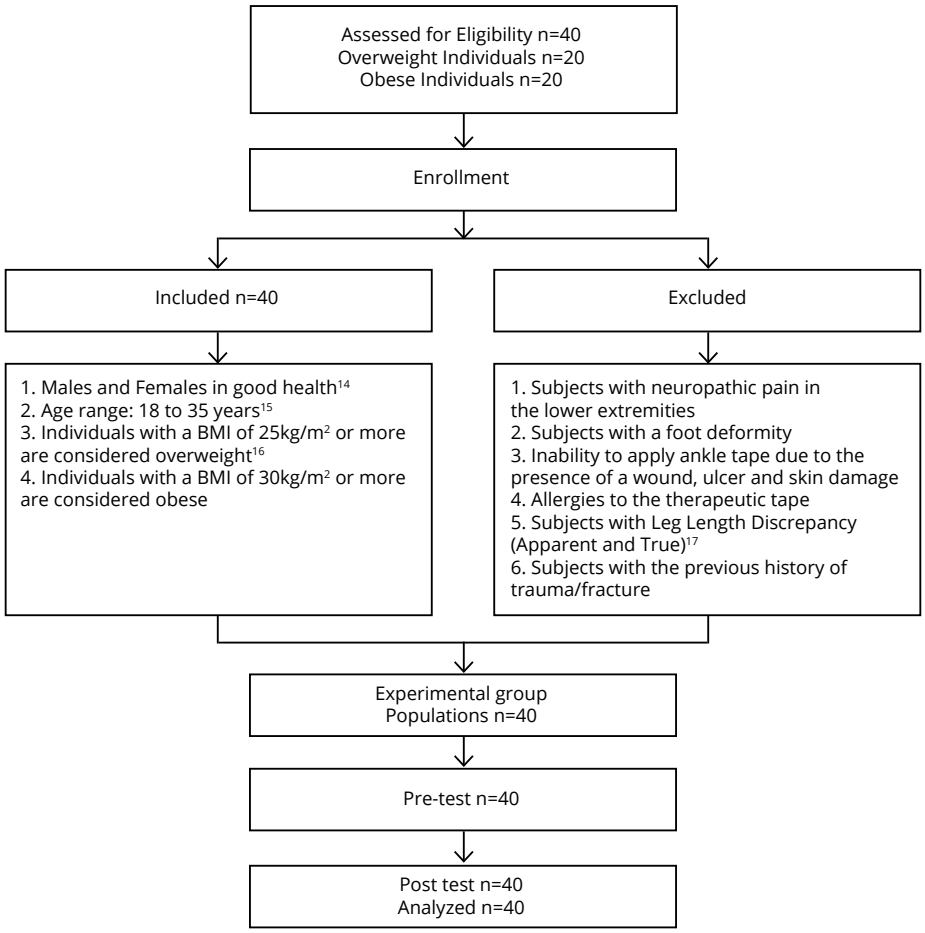
Cadence: there are two steps in each gait cycle, and cadence[24] is a measurement of half-cycles. The cadence is the number of steps made in a given amount of time. It is measured as the number of steps/sec or per minute which is approximately 70 steps/sec.

Statistical analysis: Data were analyzed using the statistical software Statistical Package for the Social Sciences (SPSS) 20.0 (Armonk, New York: IBM Corporation). Shapiro- Wilk test was used as the sample size was less than 50 To assess the normality of data. As data followed a non-normal distribution ($p<0.05$), a nonparametric test was applicable. Within-group data analysis was performed by Wilcoxon Signed Rank test and between-group analysis was performed by Mann Whitney U test. The p-value ≤ 0.05 was considered statistically significant. The effect size was calculated by Cohen's d method for within the group by the formula: (M1-M2)/SDPre[19], where M1 was the Mean of post-intervention value, M2 was the Mean of pre-intervention values, and SD was the standard deviation of pre-intervention values and post hoc retrospective power analysis was done by using G* power software.[2]

3. Results

From October 2022 to November 2022, 40 participants were assigned to rigid taping of Achilles tendon based on their BMI as shown in Figure 4.

Figure 4. Flow chart of the Study



Source: the authors (2023).

Demographic variables in overweight and obese individuals are expressed as Median ± IQR and Mean ± SD. The analysis revealed that weight is more regularly distributed than height, age and BMI, Table 1.

Table 1. Normality of demographic variables in overweight and obese individuals

Demographic Variables	**Median± IQR**	**Mean ±SD**	**p-value***
Age (Years)	23.00(21.00-24.00)		.000
Weight(kg)		79.56±13.64	.143
Height(m)	79.56±13.65		.018
BMI (kg/m²)	30.25(27.20-32.63)		.000

Abbreviation BMI-Body Mass Index, Kg-Kilogram, M-Meter.
Shapiro-Wilk test, * p-value set at > 0.05.
Source: the authors (2023).

Pretest baseline variables are expressed as Median± IQR indicating a not normal distribution of pre-test baseline variables in overweight and obese individuals, Table 2.

Table 2. Normality test for overall baseline variables in overweight and obese individuals

Variables	Median± IQR	Range	p-value*
Step length Pre(m)	0.57(0.51-0.61)	0.42-0.8	.033
Stride length Pre(m)	0.63(0.58-0.66)	0.49-0.90	.017
Cadence Pre (steps/minute)	99.8(89.75-105.80)	58.82-118.56	.007

Abbreviation IQR -Interquartile Range. Shapiro-Wilk test, * p-value set at >0.05.
Source: the authors (2023).

Outcomes measures revealed a significant difference within group after intervention and no significant difference between groups after intervention as indicated by p-value. Cohen's d value for non-parametric data represents the large effect size of the intervention[24], Table 3.

Table 3. Within group statistical analysis of overweight and obese population

Variables	Total population n=40	Effect size
	p-value* (Within Group) Pre and Post Analysis	
Step length (m)	0.000	4.65
Stride length(m)	0.000	3.16
Cadence (steps/minute)	0.002	2.09

Note: *Wilcoxon Signed Rank test. p-value set at <0.05.
Source: the authors (2023).

4. Discussion

This study explored changes in gait indicators in overweight and obese populations after rigid Achilles tendon taping.[25] Study Location is Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar Deemed to be university, Mullana, Haryana, India. In overweight or obese population, gait is drastically affected. Weight increment can cause the tendon to be overused and stressed.[26] The risk of falling can also rise as a result of these changes.[27] The Achilles tendon is essential for walking and bridges posterior leg muscles to heel. The Achilles tendon can be supported and stabilized using rigid taping intended to support the area. It may also aid in avoiding additional tendon damage and alter gait parameters.[28] In the acute and chronic stages of Achilles tendinopathy, rigid taping is frequently utilized as an adjuvant or temporary treatment to limit motion, decrease edema, and support anatomical components.[29] In order to prevent re-injury, it is also utilized after an injury. In the acute and chronic stages of Achilles tendinopathy, rigid taping is frequently utilized as an adjuvant or temporary treatment to limit motion, decrease edema, and support anatomical components.

In order to prevent re-injury, it is also utilized after an injury.[30] The components selected in this study consisted of Step length, Stride length and Cadence. In this study, the alternate hypothesis is accepted, indicating that after rigid taping of the Achilles tendon, there are significant differences in step length, stride length, or cadence in overweight and obese individuals indicating taping modifies gait pattern in high BMI population Also, no studies have utilized the highly reliable and simple-to-use gait analyzer application for the analysis of gait parameters.[31] The results indicate that there was a higher proportion of females than males in the sample. The Shapiro-Wilk test was used to determine the normality of demographic variables as sample size was less than 50.[32] The baseline variables age, height, and BMI have a non-normal distribution compared to weight as in Table 1. The distribution for the outcome parameters step length, stride length and cadence indicate that all variables had a non-normal distribution. The study found that the Achilles tendon rigid taping had an impact on the overweight and obese within group's gait patterns. The changes in step length, stride length, and cadence were all statistically significant within groups.

The mean step length was 0.57 prior to intervention and 0.49 following intervention, while the stride length impact size was 7.33. The effects of the taping were consistent with those of a prior study by Kazis et al.[31] which found that athletic taping for hallux valgus dramatically shortens steps.[31] Also, the results of our investigation differ from those of a study conducted by Tânia Cristina Dias da Silva-Hamu et al. in which the influence of obesity in young women was associated with an increase in cadence than decrease in cadence.[33] Findings of the study suggest that overweight and obese after rigid taping is associated with reduced mobility. The shorter stride length that elderly people typically adopt lowers their risk of falling, according to a study by D.D. Espy et al.[34] Hence, a lesser fall is produced by a shorter step length. A Boston University study found that obesity is linked to mobility impairment, which can result in a lower quality of life in terms of health compared to people who do not have obesity.[35] This relationship can be used in our study, where decreasing step length following Achilles tendon taping may assist in lowering the fall ratio in overweight and obese people. Lack of mobility fall ratio is higher in this population.[36] The study concluded that the use of rigid Achilles tendon taping can improve stability and reduce the risk of falls in individuals, and can be used during gait rehabilitation to provide external support for the ankle and improve foot biomechanics in overweight and obese patients. In conducting the study there is a cost involved in acquiring the materials for rigid taping of the Achilles tendon. Also, Gait Analyzer app is a paid application used in the study for gait parameters measurement. Additionally, taping training is required to learn how to properly apply the tape. These factors may limit the applicability of rigid taping in some services. Rigid tape, on the other hand, can be a useful tool for supporting and safeguarding the Achilles tendon during the recovery process.[24] The limitation of the study is that it has not focused on temporal parameters such as gait speed, step time, and stride time which is essential for proper gait analysis, also study did not assess the long-term effects of the intervention and the generalizability of the results. Future proposals include exploring the potential benefits of combining rigid taping with Kinesio taping in gait variables and comparing the effects of Achilles tendon taping on gait characteristics in individuals with normal BMIs and high BMIs.

5. Conclusion

This study provides information about the rigid taping of Achilles tendon and its influence on gait parameters when a smartphone is used as a gait monitoring tool. In obese and overweight people, a shorter step reduces the likelihood of falling. The study shows the practical application of smartphones for measuring gait parameters. Hence, this study concludes that after Achilles tendon taping, there is no difference in gait parameters between overweight and obese individuals.

Authors' contributions

Shrestha A participated in designing the methodology of the study, drafting the manuscript, designing the study, writing and editing the manuscript. Goyal M participated in the conceptualization, designing the methodology of the study and reviewing the manuscript. Goyal K participated in the analysis and interpretation of data and critically reviewed the manuscript for intellectual content.

Conflicts of interest

No financial, legal, or political conflicts involving third parties (government, private companies, and foundations, etc.) were declared for any aspect of the submitted work (including but not limited to grants and funding, advisory board participation, study design, manuscript preparation, statistical analysis, etc.).

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