Vol. 5 No. 2 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Comparative Effects Of Muscle Energy Technique And Bowen Technique In Prolonged Standing Individuals With Calf Tightness

Ahsan Nisar
Department of Doctor of Physical Therapy- Government College University, Faisalabad Email: ahsannisar17@gmail.com
Haram Yaqoob *
Department of Doctor of Physical Therapy- Government College University, Faisalabad Email: pt.gcuf07863@gmail.com
Jharna Latif
Department of Doctor of Physical Therapy- Government College University, Faisalabad Email: jharnalatif230@gmail.com
Naveera Noor
Department of Doctor of Physical Therapy- Government College University, Faisalabad drnaveera786@gmail.com
Wajeeha Sarwar
Department of Doctor of Physical Therapy- Government College University, Faisalabad Email: jiyasarwar558@gmail.com
Iqra Tanzeem
Department of Doctor of Physical therapy -The University of Faisalabad
Email: iqratanzeem451@gmail.com

Author Details

Keywords: Muscle Energy Technique, Bowen Technique, Calf Muscle Tightness

Received on 05 Mar 2026

Accepted on 27 Mar 2026

Published on 08 Apr 2026

Corresponding E-mail & Author*:

Haram Yaqoob *
Department of Doctor of Physical Therapy- Government College University, Faisalabad Email: pt.gcuf07863@gmail.com

Abstract

Calf muscle tightness is a prevalent issue among people who stand for extended periods of time. This tightness leads to decreased flexibility, restricted range of motion (ROM), and increased pain, adversely affecting lower limb function. This study aims to compare the effects of MET and Bowen Technique in individuals with calf tightness due to prolonged standing. In this RCT study, participants were randomly allocated to group A receiving METs and group B receiving Bowen Therapy intervention using a lottery method. Lower extremity function (was measured via Lower Extremity Functional Scale-questionnaire), pain intensity (were measured using the Numerical Rating Scale), and ankle dorsiflexion flexibility (weight bearing lunge test) before the start of the intervention and after the intervention.

The study results revealed significant improvement in pain ($p< 0.05$), ankle dorsiflexion ($p< 0.05$) and functionality ($p< 0.05$) in both METs and Bowen technique groups. Statistically significant improvement was observed in METs group rather than Bowen technique in reducing pain ($p< 0.05$), and enhancing ankle dorsiflexion ($p< 0.05$) and functionality ($p<$
0.05) in young individual with calf muscle tightness. The study concluded that both METs and Bowen technique showed notable advantages, but METs was especially

successful in lowering pain and enhancing range of motion and function in individuals with calf muscle tightness.

Introduction

Professions which require prolonged standing are at heightened risk of developing calfrelated musculoskeletal disorder (Bernardes et al., 2023). The professional duties including extended periods of standing can result in development of calf tightness (Alias et al., 2020). This condition often results in reduced ROM and flexibility, compromising functional performance of the limb. Flexibility is vital for sustaining optimal lower limb biomechanics and for the prevention of injury (Gohel et al., 2024). Lower leg is comprised of four muscle compartments which include superficial posterior, deep posterior, anterior, and lateral. The Tibialis posterior, flexor hallucis longus, flexor digitorum longus, and popliteus together make up the deep posterior compartment of leg Whereas, superficial posterior compartment includes the gastrocnemius, soleus and plantaris muscle (Murdock et al., 2020). Gastrocnemius muscle belly merges with belly of soleus muscle distally to make achilles or calcaneal tendon which has its insertion over the posterior surface of calcaneus (Bordoni et al., 2018). The upper and most superficial muscle, gastrocnemius and deep portion which includes the soleus muscles, both make up the majority of the calf muscle complex which plays a vital role in Lower limb mobility and biomechanics. Functionally, the gastrocnemius contributes to both plantarflexion and knee flexion, whereas the soleus acts only at the ankle joint to facilitate plantar flexion (Zunzunwala, Phansopkar et al., 2021) Both superficial and deep muscles of calf get their nerve supply through tibial nerve (S1, S2). The nerve go via the popliteal fossa and divides into branches for the gastrocnemius, soleus, popliteus, and plantaris muscles. Tibial nerve also gives off a sensory branch to supply the skin of posterior lower leg, which will continue as sural nerve (Binstead et al., 2017).

The etiology of calf tightness has a multifactorial origin, often resulting from dehydration, inadequate muscular stretching, prolonged physical exertion, and general muscle weakness. In severe presentations, vascular conditions such as arterial claudication may further aggravate the symptoms (Panchal et al., 2023). The signs and symptoms reported from individuals having calf muscle tightness include affected walking and balance due to sore, cramping, and restricted range of motion. Muscle rigidity, edema, bruises, and trouble standing on tiptoe are other symptoms. Sometimes, tightness in the calves might also indicate a more serious problem, such as deep vein thrombosis or peripheral vascular disease (Mohamed et al., 2022). Restricted ankle dorsiflexion due to a tight calf muscle has been linked numerous lower limb problems i.e plantar fasciitis, gastrocnemius strains, and Achilles tendinitis. (Phansopkar, 2020). It is speculated that dorsiflexion ROM limitations can happen due to reduced extensibility of the calf muscles and limited dorsal talus glide on tibia. As the individuals do tasks which involve lowering the body, enhancing flexion on knee, this needs tibia's forward movement over the foot, so enhancing the dorsiflexion. Limited dorsiflexion persons may attempt to compensate the ROM deficit in the anteroposterior plane by performing movement in the transverse or coronal plane all the way through the kinetic chain. The compensation can be in the sort of overpronation of foot, internal tibial rotation, medial knee displacement, internal femoral rotation, increased hip adduction or drop in pelvis, thus producing dynamic knee valgus (Wyndow et al., 2016). Among the therapeutic approaches employed to address these musculoskeletal impairments are Muscle Energy Technique (METs) and Bowen Technique.

A manual therapy approach known as The Muscle Energy Technique (METs) is hand on therapy wherein the patient performs controlled isometric muscle contractions while the therapist applies counter resistance. (Thomas, et al,. 2019) .This active engagement facilitates stretching, strengthening, and relaxation of key muscles (Franke et al., 2015).

Empirical studies highlights that MET is effective in enhancing muscle extensibility and joint mobility (Fryer, 2011). Active muscular relaxation is another name for this strategy, which focuses mostly on soft tissue (Batool et al., 2024). It has been successfully applied to improve the length of muscles that lack flexibility (Gohel et al., 2024). Classified as an active soft tissue technique, METs is known to enhance muscular relaxation and has been broadly utilized to enhance range of motion (ROM) and correct biomechanical dysfunctions (Ballantyne et al., 2003).

Similarly, the Bowen Technique is a therapeutic soft tissue technique involving precise, gentle rolling motions applied by the therapist's fingers or thumbs over specific muscles, tendons, ligaments, and fascia (Marr et al., 2011). The rolling movements, called Bowen Moves are intended to improve connective tissue flexibility and optimize muscle activation (Sanaullah and Memon, 2022). Evidence indicate that Bowen Technique, when compared to other manual therapies such as ischemic compression and myofascial release, may yield better effects concerning pain reduction, Range of motion improvement, along with functional restoration, particularly in cases of nonspecific musculoskeletal pain (Seemal et al., 2022).

Despite the established benefits of both METs and Bowen Technique individually, there is a lack of limited comparative research evaluating their specific impact on calf muscle tightness among individuals exposed to prolonged standing. Bridging the gap could inform targeted therapeutic strategies to improve lower limb biomechanics and reduce work- related musculoskeletal complaints.

MATERIALS AND METHODS

This study was designed as Randomized Clinical Trial (RCT) with a total calculated sample of 52 participants, divided equally into two groups of 26 each, determined using G Power Software.

A Purposive Sampling was technique was implemented to recruit participants and the duration of this study was estimated 4 months, with a 2 weeks intervention period. Data was collected at 2 points that start from initial assessment at pre-treatment as baseline measure, and 2nd week post treatment for groups 1 and 2. Participants were randomly allocated to Group A and Group B using a lottery method, where each subject's name was written on a slip, mixed thoroughly in a container, and then drawn alternately to guarantee equal chances of assignment and to diminish selection bias, hereby sustaining comparability between groups. The study was conducted in multiple settings, including Faisal Hospital, Mujahid Hospital, Al-Faisal Hospital, and Health 360 Clinic.

Inclusion criteria

The participants were selected based on this:

25-40 years (Aali et al. 2024)

Male and Female (Kage et al., 2017)

Daily standing duration exceeding 4 hours(Aali et al., 2024)

Prolonged standing (≥20 min) uninterrupted (Coenen et al., 2017)

Weight bearing lunge test value less than 12cm (Gohel et al., 2024) • Willingness of participants (Kage et al., 2017)

Exclusion criteria

Lower Limb Fractures, and surgery (Seemal et al., 2022)

Spinal Conditions i.e. disc problem spondylosis (Aali et al., 2024)

Neuropathies i.e. Peripheral Neuropathy, Diabetic Neuropathy (Aali et al., 2024) Ankle and Knee Injury (Gohel et al., 2024)

Having congenital anomaly or post traumatic deformity of lower limb (Kaur et al.,2023)

Outcome Measures

Pain Intensity

Ankle Dorsiflexion ROM
Lower extremity function

Data Collection Tools
Data collection tools employed in this research were:
Lower Extremity Functional Scale -Questionnaire
Numeric Pain Rating Scale (NPRS)
Weight Bearing Lunge Test (WBLT)

RESULTS
The objective of the study was to determine the comparative impact of muscle energy technique and bowen technique in prolonged standing individuals with calf tightness.
Before conducting inferential statistics, normality of data was checked. P value more than 0.05 is considered for normal distribution of data (Kim, 2013). There is a common concept spread falsely that if sample size n≥ 30, then Z distribution must be used and if sample size n < 30, then t distribution should be applied for statistical testing. Evidence states the rule for this which is contrary to this common myth. Rule states that whenever population standard deviation σ s not known and the sample is collected randomly from a population which is normally distributed, then in this case Z distribution isan approximation to the t distribution and t distribution should be applied on the basis of both theoretical and practical grounds. Z distribution should only be used if population standard deviation σ is known. Thus, if σ is not known, the skewness of population is checked, if the data is found skewed then alternative or non-parametric tests are applied, while if data is found non-skewed or normal then t distribution is used in whatever the sample size of the study (Ozgur and Strasser, 2005).
In the current research analysis, data followed the non-normal distribution for NPRS and WBLT, so non-parametric tests were employed. While, the data followed the normal distribution for LEFS, so parametric tests were utilized. As data was found non-normally distributed for NPRS and WBLT were not met, so Mann Whitney U test was conducted to find difference in Group 1 and 2 to find the difference in NPRS and WBLT at 2 time points. Wilcoxon signed rank t test was conducted for within group analysis of NPRS and WBLT. While, data was found normally distributed for LEFS were met, so Independent sample t test was conducted to find difference in Group 1 and 2 to find the difference in
LEFS at 2 time points. Paired sample t test was conducted for within group analysis of LEFS. The results of Mann Whitney U test, Wilcoxon signed rank t test, Independent sample t test and Paired sample t test were presented in the tabular form shows and graphs.

Normality Testing of Outcome Measures at Baseline

Table 1.1 Normality Test for NPRS, WBLT and LEFS at Baseline.

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	**Df**	**Sig.**	**Statistic**	**df**	**Sig.**
NPRS at Baseline	.310	45	.000	.731	45	.000
WBLT Dorsiflexion ROM at Baseline	.308	45	.000	.676	45	.000

LEFS at Baseline	.132	45	.046	.959	45	.110

*NPRS= Numerical Pain Rating Scale, *WBLT=Weight Bearing Lunge Test, *ROM=Range of Motion, *LEFS=Lower extremity Functional Scale, *Sig= Significance Value

The above table represents the results of the normality test for the NPRS, WBLT and LEFS. For the Shapiro-Wilk Test the value of significance should be above 0.05. In the results above, the significance value at baseline was 0.000 both for NPRS and WBLT that are below 0.05 which means that data in this case is non-normally distributed. While, the significance value for LEFS was .110 that is above 0.05 which means that data in this case is normally distributed.

Descriptive Statistics for Age

Table 1.1: Descriptive statistics for age in the sample

	Minimum	**Maximum**	**Mean±S.D**
Age of Sample	25	40	34.18± 3.563

*S.D=Standard Deviation

Above table displays minimum and maximum age of patients in the sample. Minimum age was 25 years in the sample. Maximum age was 40 years in the sample. Table demonstrates mean and standard deviation of the sample being 34.18± 3.563 years.

Descriptive Statistics of Gender

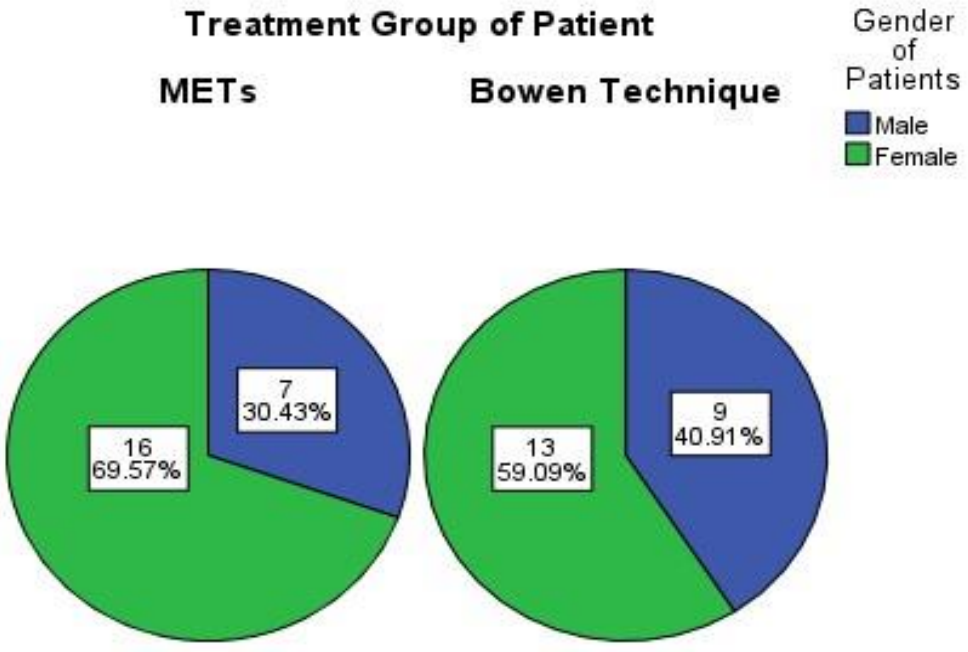


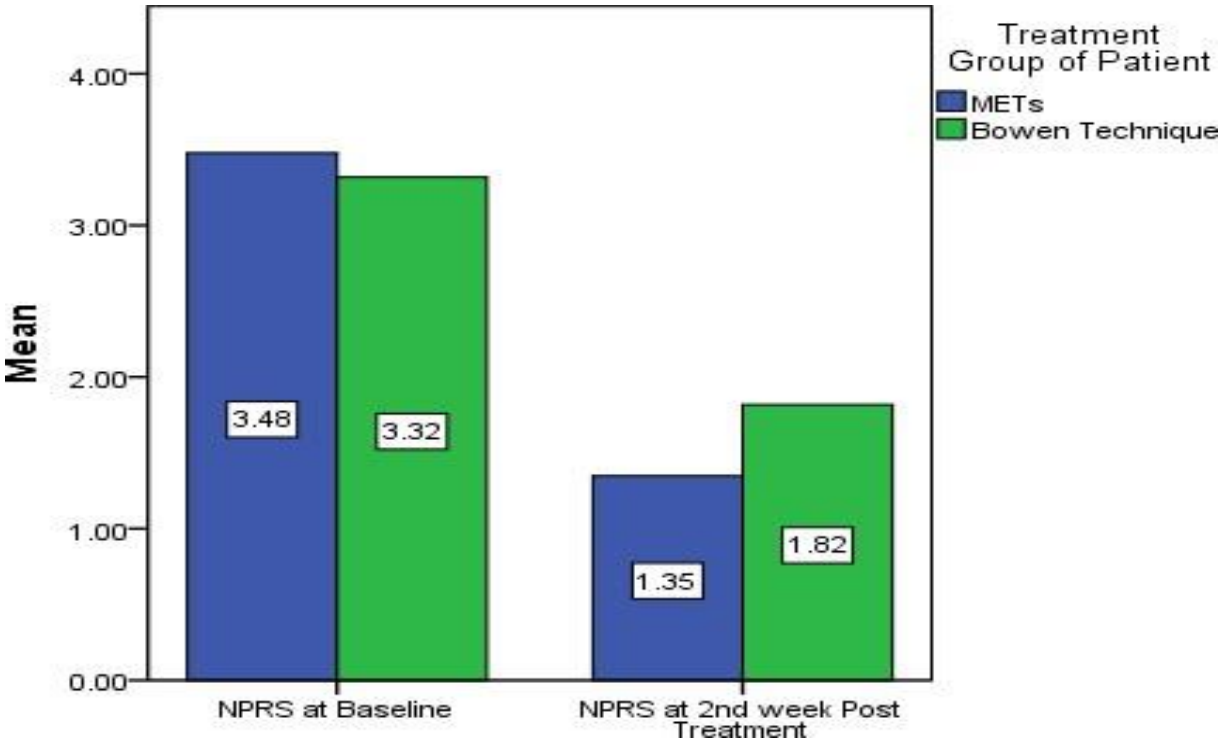
Fig 4. 1: Pie Chart showing gender distribution in both treatment groups.

*MET=Muscle Energy Technique

Above Pie chart represents the distribution of the gender in both groups. METs Group comprised of 16 (71.42%) females and 7 (28.57%) males, whereas Bowen Technique

Group contained 13 (57.14%) females and 9 (42.85%) males.

Descriptive Statistic of the NPRS



Multiple Bar Chart of mean NPRS at 2 time points in both groups.
*NPRS= Numerical Pain Rating Scale

The plot above displays decrease in mean NPRS scores in both groups from baseline to 2nd week follow up. NPRS scores improved from 3.48 at baseline to 1.35 at 2nd week post treatment in METs Group. NPRS score improved from 3.32 at baseline to 1.82 at 2nd week post treatment in Bowen technique Group. Significant improvement was observed in both groups which is evident from mean differences of groups from baseline to 2nd week post treatment.

Inferential Statistics for NPRS

Comparison of mean change in NPRS in both groups Mann Whitney U-Test

Results demonstrated statistically non-significant difference of mean rank NPRS score at Baseline between both groups with p value > 0.05. Statistically significant difference was noticed in NPRS score at 2nd week post treatment post treatment between 2 groups with p value < 0.05.

*MET=Muscle Energy Technique, *NPRS= Numerical Pain Rating Scale

Table 1.3 Between group comparison for mean rank change in NPRS

	METs Group			**Bowen Technique Group**				
Session	**N**	**Mean ± S.D**	**Mean Rank**	**N**	**Mean ± S.D**	**Mean Rank**	**Mann Whitney U**	**p-value**
Baseline	23	3.47±.510	24.28	22	3.31±.646	21.66	223.500	.448
2nd week	23	1.34±.486	18.48	22	1.81±.588	27.73	149.000	.008

Within Group Comparison for NPRS Wilcoxon Sign Rank Test for NPRS
The table demonstrates significant improvement in median NPRS score in METs Group from median of 3 at baseline to median of 1 at 2nd week post treatment session with p value less than 0.05. Significant improvement was also demonstrated in NPRS score in Bowen Technique Group from median of 3 at baseline to 2 at 2nd week post treatment session with p value less than 0.05.

Table 1.4: Within group comparison by Wilcoxon Sign Rank Test for NPRS

Treatment Group	**Baseline**			**2nd week**			**p-value**
	N	**Mean ± S.D**	**Median**	**N**	**Mean ± S.D**	**Median**	
MET Group	23	3.47±.510	3	23	1.34±.486	1	0.000
Bowen Technique Group	22	3.31±.646	3	22	1.81±.588	2	0.000

*NPRS= Numerical Pain Rating Scale, *SD=Standard Deviation, *p=Probability Value

Descriptive Statistic of the WBLT DF ROM

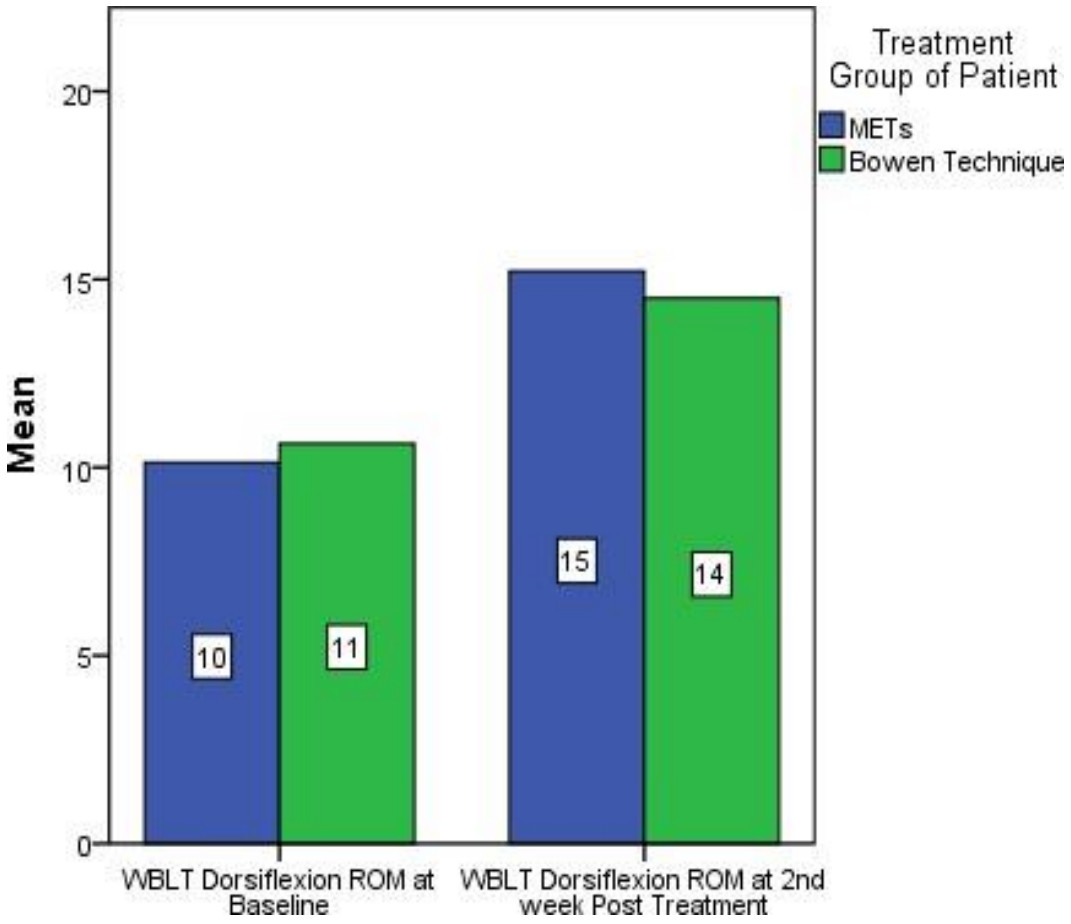


Fig 4. 2: Multiple Bar Chart of mean WBLT DF ROM at 2 time points in both groups. *WBLT=Weight Bearing Lunge Test, *ROM=Range of Motion

The plot above displays increase in mean WBLT DF ROM scores in both groups from baseline to 2nd week follow up. WBLT DF ROM scores improved from 10 at baseline to 15 at 2nd week post treatment in METs Group. WBLT DF ROM score improved from 11 at baseline to 14 at 2nd week post treatment in Bowen technique Group. Significant improvement was observed in both groups which is evident from mean differences of groups from baseline to at 2nd week post treatment.

Inferential Statistics for WBLT DF ROM

Comparison of Mean Change in WBLT DF ROM In Both Groups

Mann Whitney U-Test

Results demonstrated statistically non-significant difference of mean rank WBLT DF ROM score at Baseline between both groups with p value > 0.05. Statistically significant difference was noticed in WBLT DF ROM score at 2nd week post treatment post treatment between 2 groups with p value < 0.05.

Table 1.5: Between group comparison for mean rank change in WBLT DF ROM

*MET=Muscle Energy Technique, **WBLT=Weight Bearing Lunge Test, *ROM=Range of Motion, *DF=Dorsiflexion

	METs Group			**Bowen Technique Group**				
Session	**N**	**Mean ± S.D**	**Mean Rank**	**N**	**Mean ± S.D**	**Mean Rank**	**Mann Whitney U**	**p-value**
Baseline	23	10.13±1.100	20.04	22	10.64±.581	29.00	185	.081
2nd week	23	15.22±.951	26.09	22	14.50±.598	16.73	115	.001

Within Group Comparison for WBLT DF Wilcoxon Sign Rank Test for WBLT DF ROM

The table presents significant improvement in median WBLT DF ROM score in METs Group from median of 10 at baseline to median of 15 at 2nd week post treatment session with p value less than 0.05. Significant improvement was also demonstrated in WBLT DF ROM score in Bowen Technique Group from median of 11 at baseline to 15 at 2nd week post treatment session with p value less than 0.05.

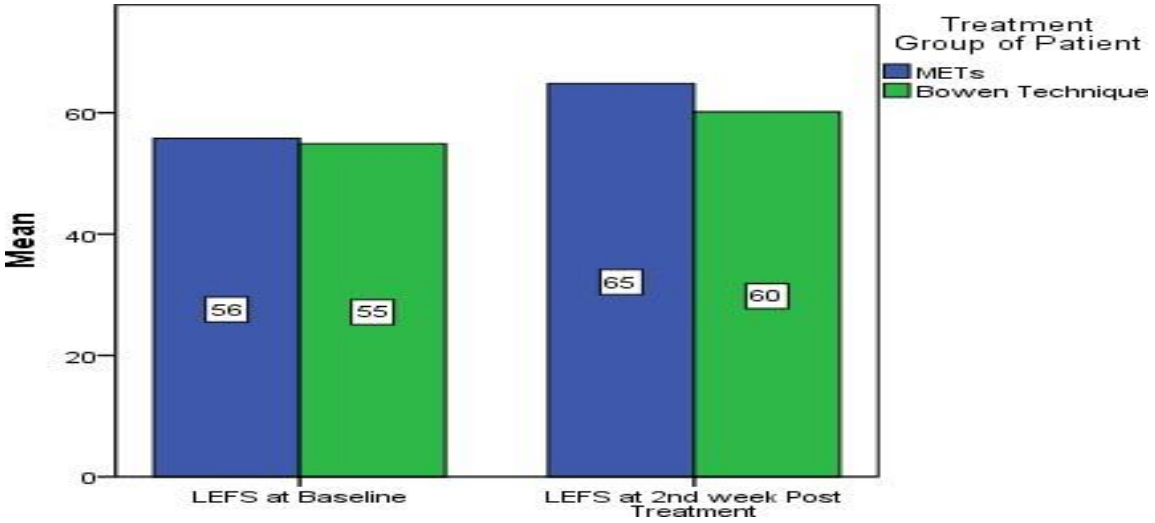
Table 1.6: Within group comparison by Wilcoxon Sign Rank Test for WBLT DF ROM

Treatment Group	**Baseline**			**2nd week**			**p-value**
	N	**Mean ± S.D**	**Median**	**N**	**Mean ± S.D**	**Median**	
MET Group	23	10.13±1.100	10	23	15.22±.951	15	0.000
Bowen Technique Group	22	10.64±.581	11	22	14.50±.598	15	0.000

*MET=Muscle Energy Technique, **WBLT=Weight Bearing Lunge Test, *ROM=Range of Motion, *DF=Dorsiflexion, *SD=Standard Deviation, *p=Probability

Value

Descriptive Statistic of the LEFS



Multiple Bar Chart of mean LEFS at 2 time points in both groups.
*LEFS=Lower Extremity Functional Scale
The plot above displays increase in mean LEFS scores in both groups from baseline to 2nd week post treatment. LEFS scores improved from 56 at baseline to 65 at 2nd week post treatment in METs Group. LEFS score improved from 55 at baseline to 60 at 2nd week post treatment in Bowen technique Group. Significant improvement was observed in both groups which is evident from mean differences of groups from baseline to at 2nd week post treatment.

Inferential Statistics for LEFS
Comparison of Mean Change in LEFS in both groups Independent Sample t Test
Results presents no significant difference of LEFS at baseline between both groups with p value being more than 0.05. However, the p-value for 2nd week is smaller than the selected value of alpha i.e. $\alpha = 0.05$. So, the alternative hypothesis is accepted. Thus, significant difference was observed in LEFS score at 2nd week post treatment between the 2 groups.

Table 1.7: Between group comparison for mean change in LEFS

Session	**METs Group**		**Bowen Technique Group**		**P. Value**
	N	**Mean± S.D**	**N**	**Mean± S.D**	
Baseline	23	55.78±3.567	22	54.91±3.741	.427
2nd week	23	64.83±4.458	22	60.18±3.568	.000

*MET=Muscle Energy Technique, *LEFS=Lower Extremity Functional Scale, *SD= Standard Deviation, *p= Probability Value

Within Group Comparison for LEFS Paired Sample t Test

The table presents significant improvement in mean LEFS in METs Group from mean of 55 at baseline to mean of 64 at 2nd week post treatment session with p value less than 0.05. Significant improvement was also demonstrated in LEFS score in Bowen Technique Group from mean of 54 at baseline to 60 at 2nd week post treatment session with p value less than 0.05.

Table 1.8:Within group comparison for LEFS

Session	**Baseline**		**2nd week**		**p. Value**
Group	**N**	**Mean± S.D**	**N**	**Mean± S.D**	
METs Group	23	55.78±3.567	23	64.83±4.458	0.000
Bowen Technique Group	22	54.91±3.741	22	60.18±3.568	0.000

*MET=Muscle Energy Technique, *LEFS=Lower Extremity Functional Scale, *SD= Standard Deviation, *p= Probability Value

DISCUSSION

The current research stated that both muscle energy technique and Bowen technique showed efficacy in lowering level of pain, and enhancing ankle dorsiflexion and functionality in young individual with muscle tightness. But, muscle energy technique was more effective in reducing pain, and enhancing ankle dorsiflexion and functionality in young individual with muscle tightness.

According to literature, a study planned to assess and contrast the short term effects on calf muscle flexibility in recreational athletes of proprioceptive neuromuscular facilitation (PNF) stretching and muscle energy technique (MET). Thirty people engaging in leisure activities were split up into two groups: Group A adhered to the MET regimen; whereas Group B adhered to the PNF protocol. Ankle dorsiflexion (ROM) was assessed both prior to and following the intervention. In conclusion, the flexibility of the calf muscle is immediately affected by both MET and PNF stretching procedures. However, studies have shown that MET was more baneficial than PNF stretching for increasing calf muscular flexibility (Gohel et al., 2024).

The study above provide consistent results with present study because in present study muscle energy was also effective in reducing calf tightness in young individuals with long standing. There were similar points in both studies such as both studies used the similar test for ankle dorsiflexion. There were some distinct features in both studies such as both studies used the different age group, above study used the age from 17-25 years while the present study used the age from 25 to 40 years. Both studies used the different intervention groups. Present study used the Bowen technique as an interventional comparison group while the above study used the PNF stretching technique. Both studies used the different treatment duration such as present study used the treatment for 2 weeks and above study used the only one session of treatment. Both studies used the different population present study used the normal young individuals while above study used the athletes.

Another study was done to assess and contrast the immediate impact of static stretching and muscle energy technique on female calf flexibility. 30 female participants, ages 18 to
25, were split into two groups. MET and Static Stretching (SS) were administered to Group A and Group B, respectively. Ankle dorsiflexion range of motion was measured pre and post intervention. After receiving the appropriate intervention for calf muscle tightness, Group A (MET) and B (SS) demonstrated that their mean range of motion (ROM) was greater than it was before the test. Thus, fewer MET repetitions may have an equivalent or larger impact than static stretching (Bindra, 2023).

The study stated above provided consistent results with present study because in present study muscle energy was also effective in reducing calf tightness i.e improve the ankle dorsi flexion in young individuals with long standing. There were similar points in both studies such as both studies used the similar test for ankle dorsiflexion. There were some distinct features in both studies such as both studies used the different age group, above study used the age from 18-25 years while the present study used the age from 25 to 40 years. Both studies used the different genders present study used the both genders male and female while above study used the females only. Both studies used the different intervention groups. Present study used the Bowen technique as an interventional comparison group while the above study used the static stretching technique.

A study evaluated the comparative impact of the Bowen technique and Muscle Energy Technique (MET) in improving hamstring flexibility and strength. The investigation showed that the Bowen technique was more effective in increasing flexibility and range of motion, while MET was better at improving muscle strength. Both techniques significantly improved flexibility, making them useful for managing hamstring tightness. Overall, the study suggests that Bowen therapy may be preferred for improving range of motion, while MET is better suited for enhancing muscle strength (Kage et al., 2017).

The study provided contrast results with present study because in present study muscle energy was also impactful in improving ankle dorsiflexion range of motion or reduce the calf tightness in young individuals with long standing as compared to Bowen technique that reduce the hamstring tightness. Both studies used the different treatment duration such as present study used the treatment for 2 weeks and above study used the only 3 alternate session of treatment. Both studies used the different population present study used the normal young individuals with calf tightness while above study used the asymptomatic individuals with hamstring tightness.

CONCLUSION

The findings of this research indicated that effectiveness of MET and the Bowen Technique as pain-relieving and enhancing function for people with tight calf muscles. Although both techniques showed notable advantages, MET was especially successful in minimizing pain and improving ROM and functional ability, indicating that it might be the treatment of choice for some patient groups. This study adds to the increasing amount of data that manual therapies can help with calf muscle tightness and emphasizes the need for more research on their individual and combined effect**.**

References

Aali, M. A., Iftikhar, S., Raza, A., & Islam, F. (2024). Exploring Calf and Hamstring Tightness among Chefs (Culinary Professionals). *Pak-Euro Journal of Medical and Life Sciences*, *7*(2), 283-288.

Alias, A. N., Karuppiah, K., How, V., & Perumal, V. (2020). Prevalence of musculoskeletal disorders (MSDS) among primary school female teachers in Terengganu,

Malaysia. *International Journal of Industrial Ergonomics*, *77*, 102957.
Anand, B., Gupta, G., & Deshmukh, R (2020). Effects of Foam Rolling and Static Stretching on Lower Back, Hamstrings and Calf Muscles. *Physiotherapy and Occupational Therapy Journal*, 13(2), 75-79.
Azizi, M., Shadmehr, A., Malmir, K., Qotbi, N., & Pour, Z. K. (2021). The Immediate Effect of Muscle Energy Technique and Whole Body Vibration on Hamstring Muscle Flexibility and Stiffness in Healthy Young Females. *Muscles, Ligaments & Tendons Journal (MLTJ)*, *11*(3).
Ballantyne, F., Fryer, G., & McLaughlin, P. (2003). The effect of muscle energy technique on hamstring extensibility: the mechanism of altered flexibility. *Journal of osteopathic medicine*, *6*(2), 59-63. Batool, K., Mehmood, M., Jafar, M., & Gull, M. (2024). Comparative efficacy of muscle energy technique and Bowen technique on hamstrings muscle tightness in chronic low back pain patients. *Pakistan Journal of Medical Sciences*, *40*(9), 2080.
Bimal Kumar, J. (2018). Effect of Bowen Technique Versus Muscle Energy Technique on asymptomatic subjects with hamstring tightness (Doctoral dissertation, Nandha College of Physiotherapy, Erode).
Binstead, J. T., Munjal, A., & Varacallo, M. (2017). Anatomy, Bony Pelvis and Lower Limb:
Calf. [Internet]. Treasure Island (FL): StatPearls Publishing. Available at:
<https://pubmed.ncbi.nlm.nih.gov/29083629/>[Accessed 20 June 2021].

Bordoni, B., & Varacallo, M. A. (2023). Anatomy, bony pelvis and lower limb, gastrocnemius muscle. *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing. Available at:
<https://www.ncbi.nlm.nih.gov/books/NBK532946/>[Accessed 20 June 2021].
Carter, B. (2001). A pilot study to evaluate the effectiveness of Bowen technique in the management of clients with frozen shoulder. *Complementary Therapies in Medicine*, *9*(4), 208-215.
Choi, W., Joo, Y., & Lee, S. (2021). Pilates exercise focused on ankle movements for improving gait ability in older women. *Journal of women & aging*, *33*(1), 30-40.
Coenen, P., Parry, S., Willenberg, L., Shi, J. W., Romero, L., Blackwood, D. M., ... & Straker, L. M. (2017). Associations of prolonged standing with musculoskeletal symptoms—A systematic review of laboratory studies. *Gait & posture*, *58*, 310-318.
Dadhaniya, A. N. (2025). Immediate Effect of Dynamic Stretching and Active Release Technique (ART) on Sit and Reach, in a Patient with Calf and Hamstring Tightness–A Comparative Interventional Study. *Indian Journal of Natural Sciences*, 16(89), 90699703.
Franke, H., Fryer, G., Ostelo, R. W., & Kamper, S. J. (2015). Muscle energy technique for non-specific low-back pain. *Cochrane Database of Systematic Reviews*, (2).
Fryer, G. (2011). Muscle energy technique: An evidence-informed approach. *International Journal of Osteopathic Medicine*, 14(1), 3-9.
Gohel, B. P., Kamalakannan, R., & Purushothaman, V. K. (2024). Immediate Effect of Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation Stretching on Calf Muscle Flexibility Among University Level Recreational Athletes–A Randomized Clinical Trial. *INTI Journal*, 2024(19), 1-6.
Hintermann, B., & Ruiz, R. (2024). Anatomic and Biomechanical Characteristics of the Ankle Joint. In *Total Ankle Replacement: A Practical Guide to Surgical Management*. Cham: Springer International Publishing, 5-18.
Ito, R., Igawa, T., Urata, R., Ito, S., Suzuki, K., Takahashi, H., ... & Kubo, A. (2024). Effects of simultaneous short-term neuromuscular electrical stimulation and

static stretching on calf muscles. *Journal of Physical Therapy Science*, 36(8), 447-451.

Ives, P. (2018). *The Efficacy of Utilizing a Voodoo Floss Technique to Create a Posterior Talar Glide and Improve Dorsiflexion Range of Motion* (Doctoral Dissertation, Azusa Pacific University).

Jang, H. J., Kim, S. Y., & Jang, H. J. (2014). Comparison of the duration of maintained calf muscle flexibility after static stretching, eccentric training on stable surface, and eccentric training on unstable surfaces in young adults with calf muscle tightness.

Physical Therapy Korea, *21*(2), 57-66.

Jayanti, N. D. (2022). The effect of static stretching calf muscle tendon unit with theraband toward range of motion dorsi flexion ankle on elderly person. Gaster, 20(2), 154-163.

Jayaseelan, V. K., Senthil, P., Rathnamala, D., & Dolla, K. (2020). A study to compare the effectiveness of Kinesio taping versus contract relax proprioceptive neuromuscular facilitation stretching of plantar flexors flexibility in amateur badminton players. *Drug Invention Today*, 14(1), 27.

Jeon, I. C., Kwon, O. Y., Yi, C. H., Cynn, H. S., & Hwang, U. J. (2015). Ankle-dorsiflexion range of motion after ankle self-stretching using a strap. *Journal of Athletic Training*, *50*(12), 1226-1232.

Kage, V., F. Bootwala and G. Kudchadkar (2017). Effect of bowen technique versus muscle energy technique on asymptomatic subjects with hamstring tightness: a randomized clinical trial. *International Journal of Medical Research & Health Sciences*, 6(4), 102108.

Kaur, J., Bindra, S., & Singh, P. P. (2023). Effect of Muscle Energy Technique Versus Static Stretching on Calf Flexibility in Females. *Indian Journal of Physiotherapy & Occupational Therapy*, *17*(3), 27.

Kelly, S., & Beardsley, C. (2016). Specific and cross-over effects of foam rolling on ankle dorsiflexion range of motion. *International Journal of Sports Physical Therapy*, *11*(4), 544.

Kim, B. J., Lee, J. H., & Han, J. T. (2014). The immediate effect of ankle balance taping using kinesiology tape on the weight-bearing ankle dorsiflexion range of motion and the dynamic balance in asymptomatic subjects. *Journal of the Korean Society of Physical Medicine*, *9*(3), 263-270.

Kim, H. Y. (2013). Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restorative dentistry & endodontics*, *38*(1), 52.

Kim, J. H., Park, J. H., Yoon, H. B., Lee, J. H., & Jeon, H. S. (2020). Immediate effects of high-frequency diathermy on muscle architecture and flexibility in subjects with gastrocnemius tightness. *Physical Therapy Korea*, 27(2), 133-139.

Lawate, M. R. N., & Dabshede, A (2024). Comparative Study of Myofascial Release versus Passive Stretching on Calf Flexibility in College-Level Amateur Football Players. *International Journal for Multidisciplinary Research*, 6(2), 1-11.

Lee, S. M., & Lee, J. H. (2017). The immediate effects of ankle balance taping with kinesiology tape on ankle active range of motion and performance in the Balance Error Scoring System. *Physical Therapy in Sport*, *25*, 99-105.

Mechner, V. (2003). The Bowen Technique. *Massage Magazine*, 106, 102-107.

Mohamed, S. H. K., ALanni, E. F., Faggal, M. S., & Ibrahim, M. M. (2022). Prevalence of Calf muscle tightness in asymptomatic flat foot subjects. *Egyptian Journal of Physical Therapy*, 10(1), 26-31.

Murdock, C. J., Munjal, A., & Agyeman, K. (2023). Anatomy, bony pelvis and lower limb: calf flexor hallucis longus muscle. In *StatPearls [Internet]*. StatPearls Publishing.Treasure

Island (FL): StatPearls Publishing. Available from:
https://www.ncbi.nlm.nih.gov/books/NBK539776/> [Accessed 20 June 2021].
Ozgur, C., & Strasser, S. E. (2005). A study of the statistical inference criteria: Can we agree on when to use Z versus t?. *Quality control and applied statistics*, *50*(2), 189-190.
Panchal, A., Sabhaya, D., & Maitri, P. (2019). Effect of PNF stretching versus static stretching on calf muscle flexibility: a comparative experimental study. *International Journal of Physiotherapy and Research*, 6, 2980-2983.
Panchal, S., Patel, D., Mall, A., & Pruchhak, T. (2023). Effects of Sub-Occipital Muscles
Inhibition and Self Stretch on Calf and Hamstring Muscle Tightness: One Time
Comparative Study. *Parul University Journal of Health Sciences and Research*, *2*(2), 14- 22.
Phansopkar, P., Tikhile, P., Sawal, R., Dhage, P., Purushe, D., & Naqvi, M. W. (2020). Early physiotherapy rehabilitation approach enhances recovery in rare acute tibial osteomyelitis post-operative in a 9 year old child. *Medical Science*, *24*(104), 2482-2486.
Ramesh, C., Thiyagarajan, A., & Durai, V. (2021). Effectiveness of static stretching and active muscle relaxation techniques on calf muscle tightness in normal subjects. International Journal of Allied Medical Sciences and Clinical Research, 9(2): 91-97.
Rout, D., Vikram, K., Tiwari, A., & Mohanty, N. R. (2024). The effectiveness of eccentric exercise and static stretching in improving the calf muscle flexibility in university male students-a comparative study. *European Journal of Physiotherapy and Rehabilitation Studies*, 4(1), 1-7.
Sanaullah, M. S. M., & Memon, A. G. M. A. G. (2022). Comparison of Bowen Technique and Sustained Stretching Technique on Hamstring Flexibility in Asymptomatic Females.
Singh, S., & Mehta, A. (2015). Effect of concomitant use of PNF stretching with thermotherapy and massage on plantar flexors flexibility in young females. *International Journal of Health and Rehabilitation Sciences*, 4, 84-94.
Škarabot, J., Beardsley, C., & Štirn, I. (2015). Comparing the effects of self-myofascial release with static stretching on ankle range-of-motion in adolescent athletes. *International journal of Sports Physical Therapy*, *10*(2), 203.
Sudhakar, S., & Nathan, C. S. (2016). Effects of Deep Stripping Massage with Eccentric
Resistance versus Static Stretch with Cryotherapy on Improving Calf Muscle Flexibility. TJPRC: *International Journal of Physiotherapy & Occupational Therapy* (TJPRC: IJPOT), 2, 45-50.
Sultana, R., Aslam, S., Ikram, I., Hanif, R., Ahsan, A., & Ashraf, H. S. (2024). Development and Evaluation of a Portable Wedge Device for Calf Stretching to Alleviate Strain and Spasms: A Randomized Controlled Trial: Portable Wedge Device for Calf Strain Relief.
Journal of Health and Rehabilitation Research, 4(3), 1-4. <
Thomas, E., Cavallaro, A. R., Mani, D., Bianco, A., & Palma, A. (2019). The efficacy of muscle energy techniques in symptomatic and asymptomatic subjects: a systematic review. *Chiropractic & Manual Therapies*, *27*, 1-18.
Tomruk, M., Tomruk, M. S., Alkan, E., & Gelecek, N. (2019). Immediate effects of ankle joint mobilization with movement on postural control, range of motion, and muscle strength in healthy individuals: a randomized, sham-controlled trial. *Journal of Sport Rehabilitation*, *29*(8), 1060-1068.

Wong, M., Jardaly, A. H., & Kiel, J. (2023). Anatomy, Bony Pelvis and Lower Limb: Achilles Tendon. In *StatPearls [Internet]*. StatPearls Publishing. Internet]. Treasure Island (FL): StatPearls Publishing. Available from: < https://www.ncbi.nlm.nih.gov/books/NBK499917/>[Accessed 20 June 2021].

Wyndow, N., De Jong, A., Rial, K., Tucker, K., Collins, N., Vicenzino, B., ... & Crossley, K. (2016). The relationship of foot and ankle mobility to the frontal plane projection angle in asymptomatic adults. *Journal of Foot and Ankle Research*, *9*, 1-7.

Youdas, J. W., Bogard, C. L., & Suman, V. J. (1993). Reliability of goniometric measurements and visual estimates of ankle joint active range of motion obtained in a clinical setting. *Archives of Physical Medicine and Rehabilitation*, *74*(10), 1113-1118.

Young, J. D., Spence, A. J., & Behm, D. G. (2018). Roller massage decreases spinal excitability to the soleus. *Journal of Applied Physiology*, *124*(4), 950-959.

Zunzunwala, S., Phansopkar, P., & Lakhwani, M. (2022). Effect of theragun on calf muscle tightness in asymptomatic individuals. Journal of Medical Pharmaceutical and Allied Science, *11*(3), 4863-6.