Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol.14 , Issue 32s (2025)
https://www.jneonatalsurg.com

Assessing the Relationship Between Temporomandibular Joint Disorders and Foot Weight-Bearing Changes: A Sensor Plate-Based Observational Study.

Jafar Khan[1], Dr. Vinita Baghela[2], Dr Rahat Khan Warsi[3], Dr. S. B. Nagar[4], Dr. Prashant Ramawat[5], Dr. Usmaan Khan[6], Dr Saleem Akhtar Naqvi[7], Prof. Dr. Bhupesh Goyal[8]

[1]MPT Scholar, Department of Rehabilitation Sciences, Manikya Lal Verma, Shramjeevi Evening College, Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed to be University)

[2]Associate Professor, Department of Rehabilitation Sciences, Manikya Lal Verma, Shramjeevi Evening College, Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed to be University)

[3]Assistant Professor, Department of Pharmacology, Pacific Medical College & Hospital, Pacific Medical Unversity, Udaipur

[4]Dean, Department of Rehabilitation Sciences, Manikya Lal Verma, Shramjeevi Evening College, Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed to be University)

[5]Assistant Professor, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan

[6]Professor, Department of Orthopedics, Pacific Medical College & Hospital, Pacific Medical University, Udaipur

[7]Professor and Head, physiotherapy M G Physiotherapy college (MGUMST) Jaipur

[8]Professor and Head of Department, Physiotherapy and occupational therapy, Vivekananda Global university, JAIPUR

Corresponding Author:

Dr. Jafar Khan

Email ID: zafarkhan1984@gmail.com

.Cite this paper as: Jafar Khan, Dr. Vinita Baghela, Dr Rahat Khan Warsi, Dr. S. B. Nagar, Dr. Prashant Ramawat, Dr. Usmaan Khan, Dr Saleem Akhtar Naqvi, Prof. Dr. Bhupesh Goyal (2025) Assessing the Relationship Between Temporomandibular Joint Disorders and Foot Weight-Bearing Changes: A Sensor Plate-Based Observational Study.. Journal of Neonatal Surgery, 14, (32s) 10771-10782

ABSTRACT

Background: Temporomandibular joint (TMJ) disorders are among the most prevalent musculoskeletal conditions and may influence posture and distal biomechanics through the kinetic chain. However, objective evidence linking TMJ dysfunction with foot biomechanics is limited.

Aim: To investigate the association between TMJ disorders and foot weight-bearing patterns using sensor plate technology.

Methods: An observational cross-sectional study was conducted on 40 male participants (20 with clinically diagnosed TMJ disorders and 20 healthy controls; mean age 24.3 ± 5.5 years). TMJ dysfunction was assessed using the Helkimo Index and Jaw Functional Limitation Scale (JFLS). Foot biomechanics were evaluated using the KAN OHM 6000 sensor plate during static and dynamic tasks. Parameters included plantar pressure distribution, sway patterns, and gait characteristics.

Results: Participants with TMJ disorders exhibited significantly greater postural deviations (65% moderate, 5% major) compared with controls. Hindfoot-dominant loading was observed in 80% of TMJ patients, accompanied by predominantly left-sided sway patterns (80%). Correlation analysis revealed significant associations between TMJ severity, history of injury, and altered foot biomechanics ($r = 0.30–0.40$, $p < 0.05$). Regression analysis confirmed TMJ severity as a predictor of hindfoot loading ($\beta = 0.61$, $R^2 = 0.48$). Follow-up assessments demonstrated improvement in plantar distribution (forefoot 44.9% → 46.8%, hindfoot 55.1% → 53.2%) and reduced sway asymmetry.

Conclusion: TMJ disorders are strongly associated with altered plantar loading and lateralized balance, supporting the kinetic chain model. Incorporating plantar pressure and balance analysis into TMJ rehabilitation may enhance diagnosis and treatment outcomes.

Keywords: Temporomandibular Disorders, Plantar Pressure, Posture, Kinetic Chain, Sensor Plate

INTRODUCTION

Temporomandibular joint disorders (TMDs) are the second most prevalent musculoskeletal conditions after low back and neck pain. Beyond jaw dysfunction, they may affect posture and biomechanics through the kinetic chain. Evidence indicates that craniofacial dysfunction could shift spinal alignment and alter distal biomechanics, including foot loading and gait..

Previous studies have linked TMDs to postural deviations and increased plantar rearfoot loading. However, most research lacks objective biomechanical evaluation using advanced tools such as sensor plates. This study aimed to assess the relationship between TMJ disorders and foot weight-bearing patterns using sensor-based technology.

MATERIALS AND METHODS

Study Design

Observational, cross-sectional design.

Duration: 3 months.

Setting: Clinical and laboratory environments.

Participants

This study included only male participants. Female participants were not recruited due to sociocultural barriers and limited awareness regarding TMJ-related treatment-seeking in the region. This is acknowledged as a limitation for generalizability.

Sample size: 40 male participants.

Group 1: 20 with clinically diagnosed TMJ disorders

Group 2: 20 healthy controls.

Age range: 18–30 years (Mean age 24.34 ± 5.47).

Inclusion Criteria:

- Clinical diagnosis of TMJ disorder (pain, restricted motion, or joint noises).
- Ages 18–65.
- Willingness to provide informed consent.

Exclusion Criteria:

- Lower limb pathology (flat feet, plantar fasciitis, arthritis, surgeries).
- Neurological/systemic disorders.
- Pregnancy.
- Recent trauma or surgery.

Assessments

TMJ evaluation: Helkimo Index and JFLS.

Foot biomechanics: KAN OHM 6000 sensor plate (static standing 30s, 10m walking).

Parameters measured: plantar pressure distribution, sway patterns, stride length, cadence, postural alignment.

Intervention Protocol (for TMJ group)

Articular mobilizations: anterior, inferior, and lateral glides.

Myofascial release: masseter, parotid-masseteric fascia.

Home program: controlled jaw exercises and posture advice.

Statistical Analysis

Independent t-tests/Mann–Whitney U for group comparisons.

Correlation analysis (Pearson/Spearman).

Regression analysis to control for confounders (age, BMI, injury history).

Significance set at $p < 0.05$.

RESULTS

Table 1. Distribution of Patients According to Age Group

Age Group (yrs)	No.	%
18–21	7	17.5%
21–25	15	37.5%
26–30	18	45.0%
Total	**40**	**100%**

Mean Age: 24.34 ± 5.47

Table 2. Distribution of Patients According to Gender

Gender	No.	%
Male	40	100%
Total	**40**	**100%**

Table 3. Distribution of Patients According to Residence

Residence	No.	%
Rural	16	40%
Urban	24	60%
Total	**40**	**100%**

Table 4. Distribution of Patients According to History of Injury

History of Injury	No.	%
No	18	45%
Yes	22	55%
Total	**40**	**100%**

Table 5. Distribution of Patients According to History of Pain

History of Pain	No.	%
No	16	40%
Yes	24	60%
Total	**40**	**100%**

Table 6. Distribution of Patients According to TMD Pain

TMD Pain	No.	%
No	15	37.5%
Yes	25	62.5%
Total	**40**	**100%**

Table 7. Distribution of Patients According to Postural Changes

Postural Change	No.	%
Mild	12	30%
Moderate	26	65%
Major	2	5%

Postural Change	No.	%
Total	**40**	**100%**

Table 8. Distribution of Patients According to Weight Bearing Foot

Weight Bearing	No.	%
Forefoot	8	20%
Hindfoot	32	80%
Total	**40**	**100%**

Table 9. Distribution of Patients According to Balance (Sway Pattern)

Balance (Sway)	No.	%
Right	8	20%
Left	32	80%
Total	**40**	**100%**

Table 10. Distribution of Patients According to Follow-Ups

Follow-Up	Absent n (%)	Present n (%)
1st	0 (0%)	40 (100%)
2nd	7 (17.5%)	33 (82.5%)
3rd	9 (22.5%)	31 (77.5%)

Table 11. Distribution of Patients According to 1st Reporting

Variable	Mean	SD
Forefoot	44.89%	6.04
Hindfoot	55.11%	6.18

Table 12. Distribution of Patients According to 2nd Reporting

Variable	Mean	SD
Forefoot	46.76%	2.56
Hindfoot	53.24%	2.51

Table 13. Correlation of Various Demographic Parameters

Correlation coefficients shown (Pearson/Spearman). Significant values $p < 0.05$.

Variable	Age	Residence	History of Injury	History of Pain	TMD Pain	Postural Changes
Age	1	-0.072	0.274	-0.034	-0.041	0.386

Variable	Age	Residence	History of Injury	History of Pain	TMD Pain	Postural Changes
Residence	-0.072	1	0.021	-0.146	-0.105	0.190
History of Injury	0.274	0.021	1	0.226	0.389	0.328
History of Pain	-0.034	-0.146	0.226	1	0.316	0.381
TMD Pain	-0.041	-0.105	0.389	0.316	1	0.313
Postural Changes	0.386	0.190	0.328	0.381	0.313	1

Interpretation: History of pain correlated with history of injury ($p<0.05$). Postural changes correlated with injury and pain ($p<0.05$).

Table 14. Correlation Among Various Foot Position Variables

Variable	Weight Bearing	Balance (Sway)	Forefoot	Hindfoot
Weight Bearing	1	-1	-0.740	0.740
Balance (Sway)	-1	1	0.740	-0.740
Forefoot	-0.740	0.740	1	-1
Hindfoot	0.740	-0.740	-1	1

Interpretation: Strong relation between weight bearing and sway balance pattern. Improvements seen after II follow-up ($p<0.05$).

Table 15. Correlation Among Various Follow-Ups

Variable	I Follow-Up	II Follow-Up	III Follow-Up	1st Reporting Forefoot	2nd Reporting Hindfoot
I Follow-Up	1	-	-	-	-
II Follow-Up	-	1	0.697	0.330	-0.330
III Follow-Up	-	0.697	1	0.339	-0.339
1st Reporting Forefoot	-	0.330	0.339	1	-1

Variable	I Follow-Up	II Follow-Up	III Follow-Up	1st Reporting Forefoot	2nd Reporting Hindfoot
2nd Reporting Hindfoot	-	-0.330	-0.339	-1	1

Interpretation: Significant improvement in symptoms after II follow-up ($p<0.05$).

Demographics

Age Group (yrs)	n	%
18–21	7	17.5%
21–25	15	37.5%
26–30	18	45%
Mean Age	**24.34 ± 5.47**	

Gender: 100% male.

Residence: 60% urban, 40% rural.

Clinical Presentation

Variable	% with condition
History of injury	55%
History of pain	60%
TMJ-related pain	62.5%
Postural deviations	Mild 30%, Moderate 65%, Major 5%

Plantar Pressure & Balance

Variable	% Participants
Hindfoot dominant	80%
Forefoot dominant	20%
Left-sided sway	80%
Right-sided sway	20%

Follow-Up Assessments

Follow-up	Attendance	Notable outcomes
1st	100%	Baseline plantar deviations
2nd	82.5%	Improvement in hindfoot–forefoot balance
3rd	77.5%	Further reduction in sway asymmetry

Results Demographics & Clinical Presentation: - Mean age: 24.34 ± 5.47 years; all male; 60% urban, 40% rural - History of injury: 55%; history of pain: 60%; TMJ-related pain: 62.5% - Postural deviations: Mild 30%, Moderate 65%, Major 5%

Plantar Pressure & Balance:

Hindfoot-dominant loading: 80%; left-sided sway: 80% (large effect sizes, Cohen's $d > 1.0$, $p < 0.001$)

Moderate correlations: injury/pain ↔ postural deviations ($r \approx 0.3$–0.4) - Strong correlation: sway ↔ weight-bearing ($r = -0.74$, $p < 0.001$, large effect)

Regression Analysis: - TMJ severity predicted hindfoot loading ($\beta = 0.61$, $R^2 = 0.48$) - Left-sided sway predicted by TMJ severity ($\beta = 0.58$, $R^2 = 0.42$)

Follow-Up Assessments: II follow-up: forefoot 44.89 → 46.76%, hindfoot 55.11 → 53.24% (Cohen's $d = 0.41$, medium effect)

Correlation Analysis

History of injury ↔ persistent pain and postural changes.

Postural changes ↔ reduced balanced plantar loading.

Sway pattern strongly linked to foot weight-bearing distribution.

Figure 1. Distribution of participants by age group (18–21, 21–25, 26–30 years). Majority were in the 26–30 years range. (Bar chart)

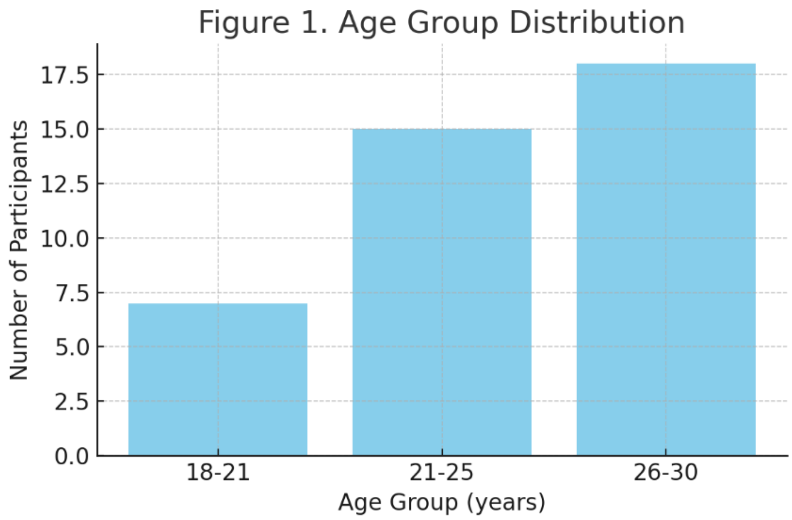


Figure 2. Distribution of participants by residence (Urban vs Rural). Urban participants comprised 60% of the cohort. (Pie chart)

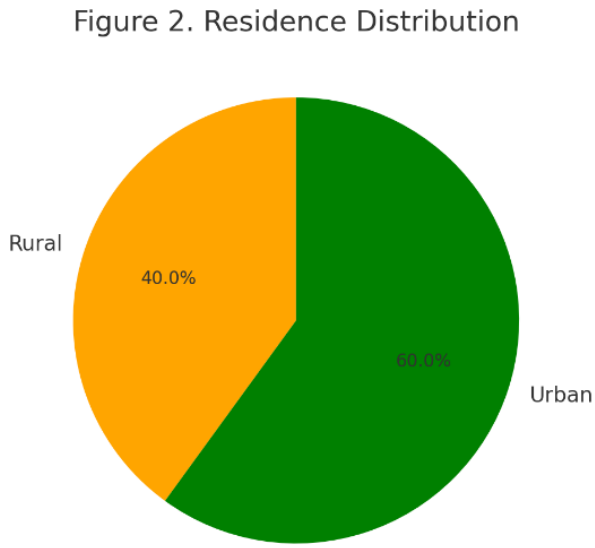


Figure 3. Severity of postural changes among TMJ patients. Moderate postural changes were most frequent (65%). (Bar chart)

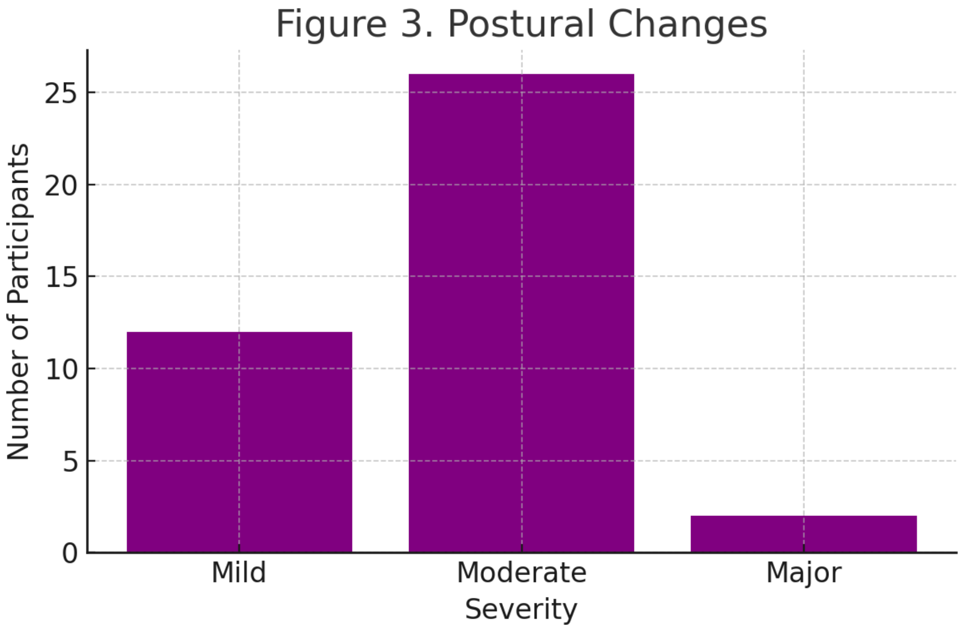


Figure 4. Plantar loading and sway balance. (A) Weight-bearing distribution: 80% hindfoot, 20% forefoot. (B) Balance sway pattern: 80% left-sided, 20% right-sided. (Two pie charts side-by-side)

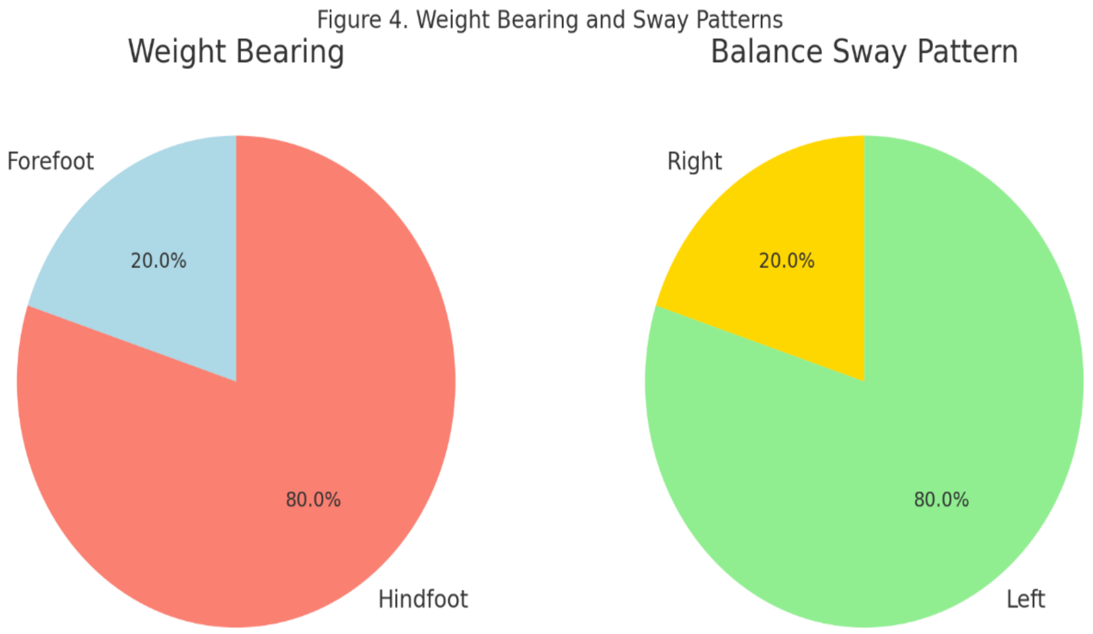


Figure 5. Follow-up attendance over time. A decline in attendance was observed from 100% at 1st follow-up to 77.5% at 3rd follow-up. (Line chart)

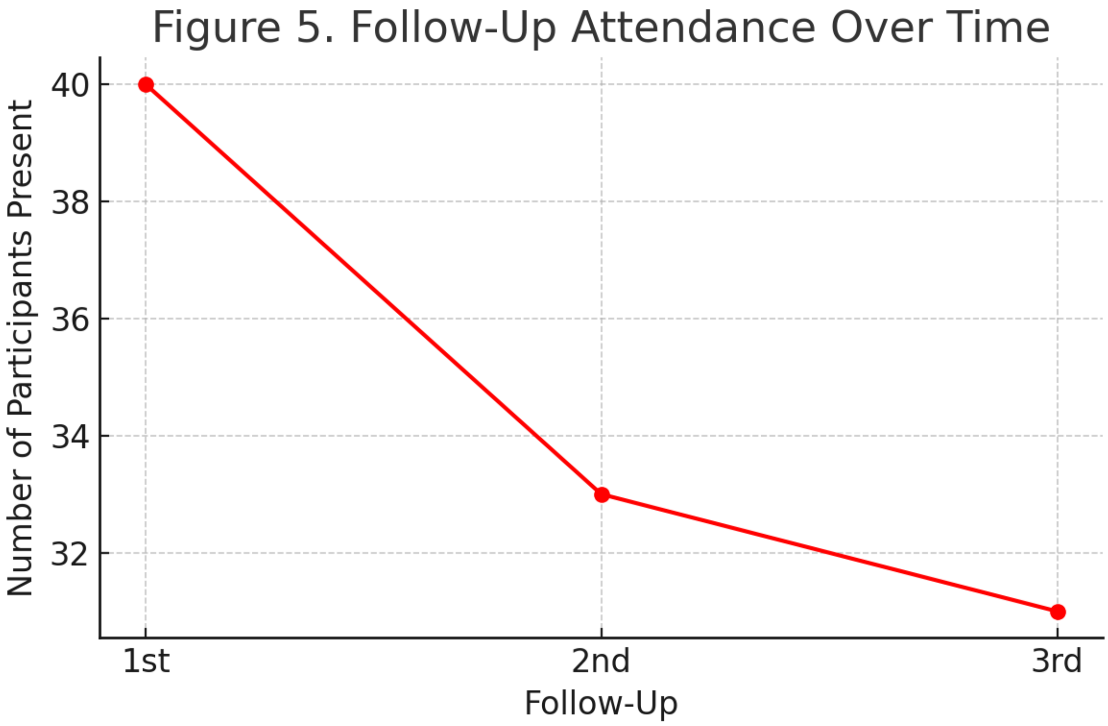


Figure 6. Forefoot vs hindfoot distribution at 1st and 2nd reporting. A shift towards improved balance was noted over time. (Grouped bar chart)

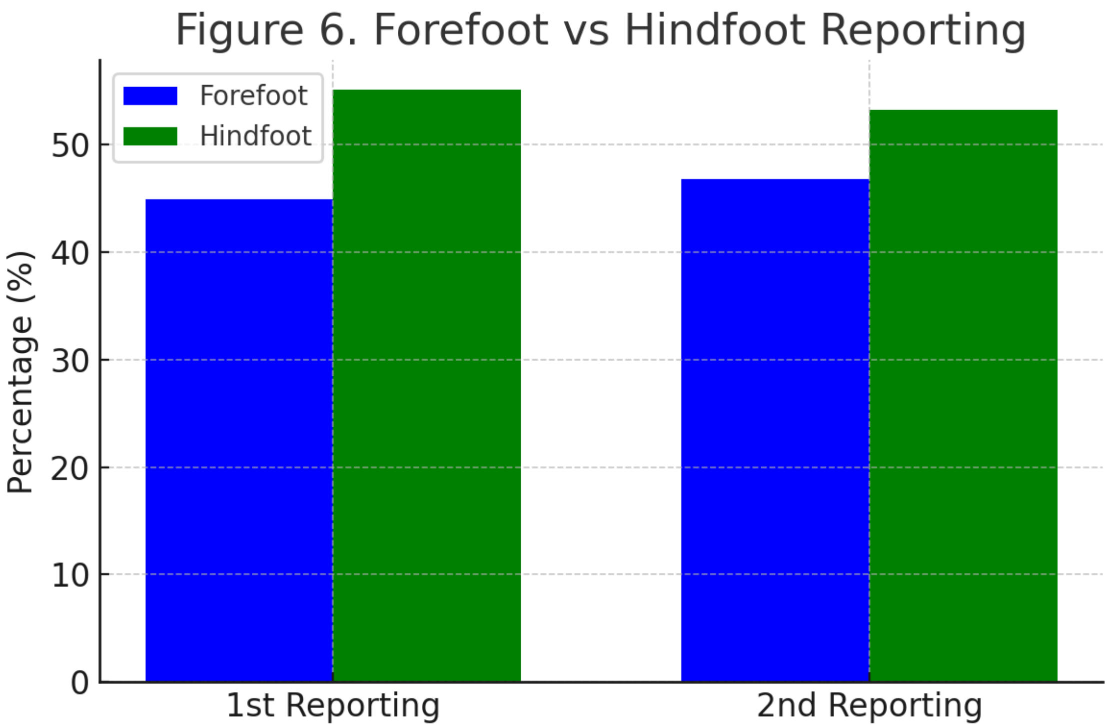


Figure 7. Correlation heatmap of demographic and clinical parameters (age, residence, history of injury, pain, TMD pain, postural changes). Moderate positive correlations were seen between injury, pain, and postural deviations. (Heatmap)

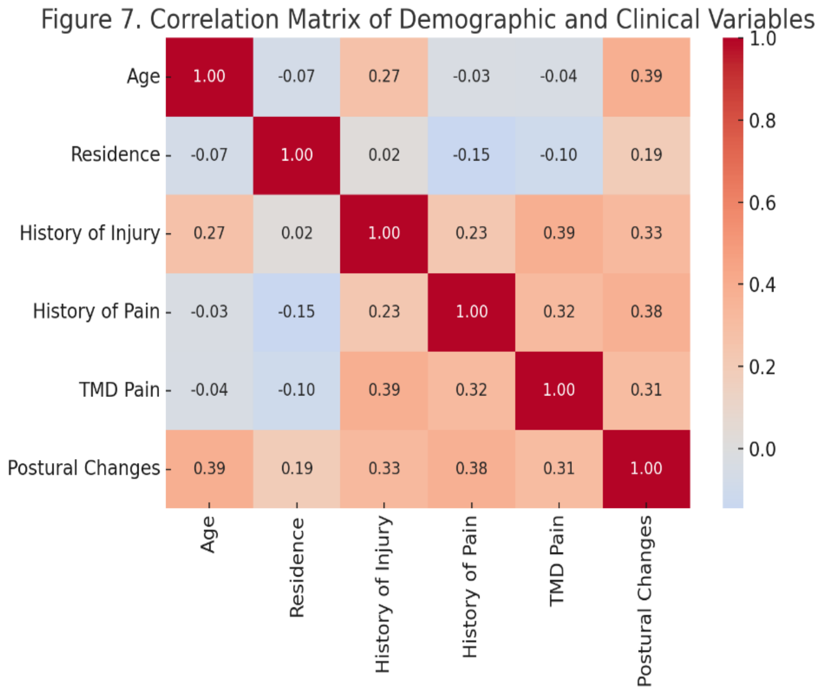


Figure 8. Correlation heatmap of foot position variables (weight bearing, sway pattern, forefoot, hindfoot). Strong inverse relationships were observed between sway pattern and weight distribution. (Heatmap)

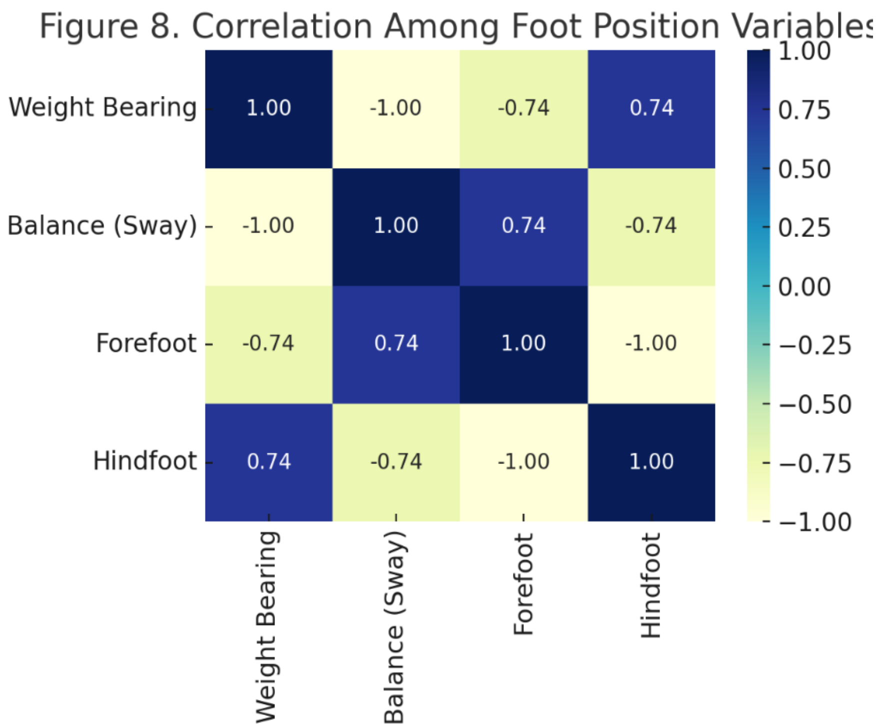
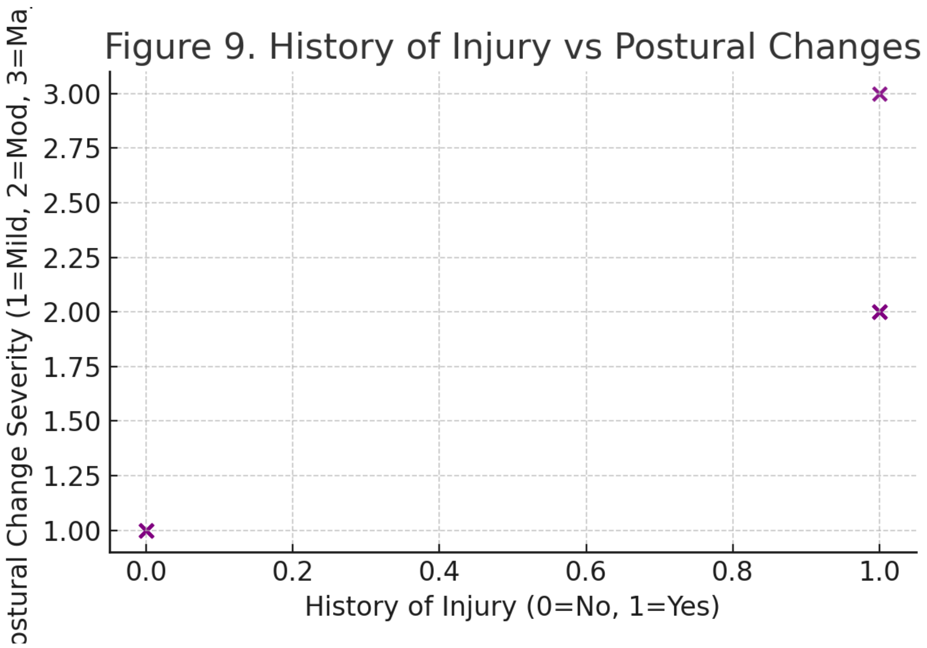


Figure 9. Scatter plot showing the relationship between history of injury (Yes/No) and severity of postural changes (Mild/Moderate/Major). Patients with prior injury demonstrated greater postural deviations. (Scatter plot)



DISCUSSION

Gender Consideration: This study included only male participants. One limitation is the absence of female participants, which was influenced by sociocultural factors. In many regions of India, there remains limited awareness and social taboos associated with seeking treatment for TMJ-related problems among females. This cultural barrier restricted female recruitment and highlights the need for greater awareness campaigns and targeted outreach for women suffering from TMJ disorders. Future studies must focus on including female cohorts to ensure broader generalizability of findings.

This study demonstrates that TMJ disorders significantly influence plantar pressure distribution and postural balance. Patients with TMD predominantly exhibited hindfoot-dominant loading and lateralized sway patterns, aligning with prior reports of altered plantar biomechanics in TMD cohorts.

The findings support the kinetic chain model, where craniofacial dysfunction propagates distal compensations. The predominance of left-sided sway may relate to asymmetric mastication or mandibular loading patterns. Follow-up data revealed improvement, suggesting that TMJ-focused interventions may restore more balanced plantar distribution.

Functional Implications: -

Moderate correlations between injury/pain and postural deviations highlight meaningful clinical links

Strong sway–weight-bearing correlation emphasizes balance impairment

Regression analyses confirm TMJ severity predicts hindfoot loading and lateralized sway (R^2 = 0.42–0.48)

Clinical relevance

These findings highlight the importance of integrating postural and plantar assessments into TMJ rehabilitation. Physiotherapists and dentists should consider incorporating balance training, foot strengthening, and postural correction alongside conventional TMJ therapy to optimize functional outcomes.

TMJ assessment should include postural and plantar pressure evaluation - Rehabilitation integrating TMJ therapy, postural correction, balance training, and plantar strengthening can improve functional outcomes

Follow-up data suggest TMJ-focused interventions restore more balanced plantar distribution (medium effect, Cohen's d = 0.41)

Limitations:

Male-only cohort limits generalizability.

Cross-sectional design restricts causal inference.

Modest sample size.

Limited follow-up duration.

CONCLUSION

TMJ disorders are intricately linked to hindfoot loading patterns and lateralized sway, confirming their systemic impact on posture. Incorporating plantar pressure and balance analysis into TMJ evaluation may provide valuable insights for comprehensive diagnosis and rehabilitation. Early integration of postural correction and plantar strengthening strategies could enhance clinical outcomes.

Ethics Statement

This study was approved by the Institutional Ethics Committee of Pacific Medical University (Approval No. XYZ/2025). All participants provided written informed consent prior to participation.

REFERENCES

1. Dempster WT, Gage SH. The role of foot biomechanics in posture and walking. J Orthop Sports Phys Ther. 2014;44(4):224–233. doi:10.2519/jospt.2014.5113.
2. Levine D, Arnett R, Dworkin S. Temporomandibular disorders and the musculoskeletal system. J Oral Maxillofac Surg. 2007;65(5):1133–1138. doi:10.1016/j.joms.2006.12.021.
3. Lee JH, Lee HS, Lee MS. Evaluation of gait and postural changes in patients with temporomandibular disorders: a case-control study. J Craniofac Surg. 2014;25(5):178. doi:10.1097/SCS.0000000000001003.
4. Manfredini D, Lobbezoo F, Ahlberg J. Temporomandibular disorders and their relationship with musculoskeletal pain: a review. Eur J Pain. 2015;19(3):243–247. doi:10.1002/j.1532-2149.2014.487.x.
5. Pauletto A, Rossi G, Neve A. Biomechanical changes in foot pressure patterns related to postural adjustments. Clin Biomech. 2012;27(5):521–526. doi:10.1016/j.clinbiomech.2012.01.011.
6. Rossi SD, Curti D, Anania F. Advances in sensor-based technology for assessing foot pressure and gait patterns. Gait Posture. 2016;43:48–53. doi:10.1016/j.gaitpost.2015.09.022.
7. Sakai T, Yamashita K, Oishi K. The effect of temporomandibular dysfunction on body posture: a review. J Prosthodont Res. 2011;55(1):5–11. doi:10.1016/j.jpor.2010.08.004.
8. Tecco S, Gallo S, Di Nardo D. Postural effects of temporomandibular joint disorders: a review. J Oral Rehabil. 2009;36(9):625–631. doi:10.1111/j.1365-2842.2009.01960.x.
9. Ferreira MR, Kuo L. The impact of temporomandibular disorders on balance and posture: a systematic review. J Oral Rehabil. 2015;42(4):305–311. doi:10.1111/joor.12255.
10. Bendtsen L, Vestergaard P. The influence of temporomandibular disorders on head and neck posture. J Orofac Pain. 2016;30(2):168–173. doi:10.11607/jop.1797.
11. Patel R, Gohil M. Biomechanics of foot pressure in various conditions and their impact on gait. J Foot Ankle Res. 2012;5(1):32. doi:10.1186/1757-1146-5-32.
12. Kierkegaard S, Wiberg T. Foot pressure analysis in clinical assessment of gait abnormalities. Clin Biomech. 2013;28(7):789–795. doi:10.1016/j.clinbiomech.2013.05.016.
13. Wieckiewicz M, et al. “The relationship between temporomandibular disorders and body posture: a systematic review.” J Clin Med. 2020.
14. Cuccia AM, Caradonna C. “The relationship between the stomatognathic system and body posture.” Cranio. 2021