International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 23s, 2025
https://theaspd.com/index.php

Analysis of Kinetic and Kinematic Gait Deviation Using Gaiton Software in Healthy Young Adults- A Cross Sectional Study

Muthukrishnan P[1], A. Subashini[2], K. Santhosh[2], R. Rajalakshmi[2], N. Priyanka[2], T. Aishwarya[2], Jeyanthi S[*3]
[1]Assistant Professor, Department of Anatomy, Sri Venkateshwaraa Medical College Hospital & Research Centre, Pondicherry University, Pondicherry, India
[2]MPT Student, Sri Venkateshwaraa College of Physiotherapy, Pondicherry University, Pondicherry, India
[3]Principal & Professor, Sri Venkateshwaraa College of Physiotherapy, Pondicherry University; Associate Dean-Research, Sri Venkateshwaraa Group of Institutions, Pondicherry, India

[*]**Corresponding author:** Dr. Jeyanthi S
E mail: drjeyanthi@svcopt.ac.in

ABSTRACT
Background: *Walking is a fundamental human locomotor activity essential for independent mobility and overall health. Gait deviations, even when subtle, can impair walking efficiency and predispose individuals to musculoskeletal complications. Comprehensive kinematic assessment is therefore vital for early identification and targeted intervention.*
Objective: *To analyze kinetics and kinematics of gait and categorize major and minor gait deviations in young adults using GaitOn, with the aim of informing personalized rehabilitation strategies.*
Methods: *A cross-sectional study was conducted among 200 healthy young adults (18–25 years) recruited from an institutional campus via convenience sampling. Inclusion criteria required normal ambulation, while exclusions included recent lower limb surgery, musculoskeletal injuries, or neurological impairments. Anthropometric data were collected, and gait was recorded using a 6-meter walkway with a dual-camera GaitOn setup. Deviations in joint kinematics were identified and classified as major (clinically significant) or minor (clinician's discretion).*
Results: *Major deviations were predominantly observed at the ankle, including increased plantarflexion and reduced dorsiflexion bilaterally, as well as altered knee extension/flexion patterns and hip flexion/extension asymmetries. Minor deviations included subtle joint angle changes, pelvic tilt variations, and patellar tracking abnormalities. These findings reflected both asymmetries and compensatory mechanisms.*
Conclusion: *GaitOn effectively identified clinically relevant and subtle gait deviations in young adults, underscoring its utility in early detection of biomechanical imbalances. Targeted interventions addressing these deviations may enhance walking efficiency and prevent future musculoskeletal complications..*
Future Scope: *Expanding to longer walkways, multi-camera or motion capture systems, and integrating force plates, EMG, and automated deviation detection could improve clinical applicability and accuracy.*
Key words: *Gait, Kinetics, Kinematics, GaitOn software, young adults*

INTRODUCTION:

Walking is a fundamental human locomotor activity that supports independent and efficient movement while offering substantial physical and psychological health benefits, particularly for older adults (Paterson & Warburton, 2010; Murtagh et al., 2015). The World Health Organization (WHO) recommends at least 30 minutes of moderate-intensity walking per day to achieve meaningful health improvements (World Health Organization [WHO], 2020). The human gait cycle comprises two primary phases: the stance phase and the swing phase. According to Perry and Burnfield (2010), the stance phase consists of four functional periods—loading response, midstance, terminal stance, and preswing—while the swing phase includes initial swing, midswing, and terminal swing.

Gait is generally defined as the coordinated motion of body segments that facilitates whole-body translation while maintaining postural balance. This complex motion is regulated by neuromuscular mechanisms involving both the brainstem and spinal cord (Dietz, 2002).

Understanding gait deviations, particularly in young adults, is essential for identifying early musculoskeletal imbalances that may contribute to injuries or long-term functional limitations. Major deviations, which typically require clinical intervention, can significantly impair mobility and increase

the risk of falls or overuse injuries. In contrast, minor deviations, although less severe, may compromise gait efficiency and predispose individuals to future complications if left unaddressed.
This study systematically examines the kinetic and kinematic gait deviations observed in young adults, categorizing them based on clinical significance. By identifying variations such as altered joint angles, pelvic shifts, and patellar tracking abnormalities, this research aims to advance the understanding of gait biomechanics and inform targeted clinical interventions

METHODOLOGY:

Study Design

A cross-sectional study with convinient sampling was conducted.

Participants

A total of 200 participants (age range 18–25 years) were recruited for this study. In the context of our gait-related research conducted on the Institute's campus, participants were recruited through communication channels, such as email newsletters, bulletin boards, and social media platforms, to invite students, staff, and faculty members. The inclusion criterion for selecting volunteers stipulated that they did not exhibit issues pertaining to movement or ambulation. Exclusion criteria included inability or difficulty walking at the indicated speeds, surgical intervention in the lower limb within the past five years, history of muscle or ligament injury in the lower extremity, and any musculoskeletal or neurological injury that alters or could alter ambulation.

RESULTS:

Demographic data and anthropometric measurements were collected from each participant, including age, gender, body weight, height, and leg dominance. These measurements are presented in Table 1. In our study, we defined leg dominance as the preferred or dominant leg that an individual naturally employs for activities such as kicking a ball or taking a step forward. The numerical data, including age, body weight, and body height, exhibited normal distributions in both subsets, categorized by gender and leg dominance.

Table 1: Demographics

	Male	Female
Age (Years)	20.5	20.34
Body Weight (Kg)	78.4	75.1
Height (m)	1.72	1.69
Gender (in number)	100	100
Leg dominance (in number)	Right-83 Left-17	Right-89 Left-11

GaitOn is the software used for analyzing spatio-temporal gait parameters presented in Table 2 and measuring joint angles throughout the different phases of walking. In our setup, we used a standard 6-meter walkway along with two digital cameras. One camera was positioned to capture the lateral view, and the other was placed to record the sagittal view, enabling precise assessment of gait dynamics and joint movement.

Table 2: Saptio temporal parameters of Gait

Group Statistics

	GENDER	N	Mean	Std. Deviation	Std. Error Mean
STEPLENGTH	1	144	71.8167	6.09769	.50814
	2	56	69.6429	7.38408	.98674
STRIDELENGTHRIGHT	1	144	1.4462E2	12.82664	1.06889
	2	56	1.3954E2	12.86428	1.71906
STRIDELENGTHLEFT	1	144	1.4392E2	12.46218	1.03851
	2	56	1.3920E2	13.47074	1.80010
WIDTHOFBASE	1	144	7.7778	3.49678	.29140
	2	56	7.0179	3.36755	.45001
DEGREEOFTOEOUT	1	144	7.5694	2.87661	.23972
	2	56	6.8929	3.21744	.42995
HEIGHT	1	144	1.7275E2	5.81909	.48492
	2	56	1.6930E2	6.40917	.85646

Gait analysis revealed multiple deviations from normative joint kinematics, categorized as either major (requiring clinical intervention) or minor (to be addressed at the clinician's discretion).

Among the major deviations, increased left ankle plantarflexion was observed throughout stance and swing phases, accompanied by reduced left ankle dorsiflexion, particularly during mid and terminal stance. Similarly, the right ankle exhibited increased plantarflexion at initial contact, loading response, and the end of mid swing, along with reduced dorsiflexion during stance. The left knee demonstrated increased extension during stance and reduced flexion at the end of mid swing. At the hip, increased right hip flexion was evident at the end of initial swing, while reduced right hip extension was noted during mid-stance—both classified as significant deviations warranting clinical attention.

The minor deviations were more numerous and varied. At the ankle, increased right plantarflexion was noted at initial contact, along with increased left plantarflexion at initial contact, pre swing, and loading response. Right ankle dorsiflexion was reduced during mid-stance, while left rearfoot eversion was diminished at mid stance and increased on the right. Knee joint analysis showed reduced left knee flexion during initial contact, terminal stance, and swing, while right knee flexion was reduced during stance and increased at the end of pre swing.

Hip kinematics revealed reduced extension on both sides during terminal stance and pre swing, with increased right hip flexion at initial contact and throughout swing. The left hip exhibited reduced flexion during swing and stance but showed an increase at the end of initial swing.

Pelvic and patellar deviations included a pelvic drop towards the right during left mid stance and a pelvic hike towards the left during right mid stance. Both patellae demonstrated increased lateral tracking relative to the second toe at mid stance, while medial tracking of the right patella was also observed, indicating possible asymmetry. Despite these deviations, left knee alignment at mid stance and right knee positioning at initial contact were within normal limits.

DISCUSSION:

The gait analysis performed with GaitOn revealed several deviations from normative joint kinematics, consistent with findings from prior research on pathological gait patterns. Major deviations such as increased plantarflexion and reduced dorsiflexion at the ankle during stance and swing phases have been previously associated with compromised push-off mechanics and impaired foot clearance, as reported by Perry and Burnfield (2010). Similar plantarflexion abnormalities observed in this study align with findings by Lewek et al. (2007), who noted that excessive ankle plantarflexion contributes to inefficient gait and increased energy expenditure. The observed alterations in knee kinematics, including increased extension during stance and decreased flexion during mid-swing on the left side, reflect a stiff-knee gait pattern frequently documented in individuals with neuromuscular impairments (Boudarham et al., 2013). This pattern can reduce limb advancement and increase fall risk, underscoring the clinical importance of these deviations. Hip joint abnormalities such as increased flexion during initial swing and reduced extension during mid-stance are consistent with gait adaptations identified in populations with reduced hip muscle strength and spasticity (Baker et al., 2009), which can adversely affect limb progression and stability. Minor deviations, including bilateral reductions in hip extension during terminal stance and pre swing, and variable knee and ankle joint angles, echo the subtle compensatory mechanisms described by Ivanenko et al. (2006) in gait adaptation studies. These minor alterations, while not immediately disabling, may contribute to long-term joint stress and gait inefficiency if left unaddressed. Additionally, pelvic and patellar deviations observed in this study are comparable to the asymmetrical pelvic motions and patellar tracking abnormalities reported by Huang et al. (2010), which can affect frontal plane stability and predispose to musculoskeletal pain. The preservation of normal left knee alignment at mid stance and right knee positioning at initial contact suggests selective joint preservation, offering potential focal points for rehabilitation efforts aimed at enhancing overall gait mechanics. In summary, the gait deviations identified in this study corroborate existing literature and highlight the utility of GaitOn in providing a detailed kinematic profile. This enables clinicians to develop targeted interventions addressing both major and minor gait abnormalities, improving functional mobility and reducing secondary complications.

CONCLUSION:

The gait analysis using GaitOn effectively identified multiple deviations in spatio-temporal and joint kinematics parameters, distinguishing between clinically significant and minor abnormalities. Major

deviations, particularly at the ankle, knee, and hip joints, highlight areas requiring focused clinical intervention to improve gait function. Minor deviations reveal subtle asymmetries and compensations that could impact long-term joint health and mobility. These findings underscore the value of comprehensive, multi-view gait assessment in guiding personalized rehabilitation strategies aimed at enhancing walking efficiency and preventing further musculoskeletal complications.

LIMITATIONS:

While the current study successfully utilized GaitOn with a 3-meter walkway and dual-camera setup to analyze gait kinematics, certain limitations should be acknowledged. The relatively short walkway length may have constrained participants' ability to achieve a fully natural and steady-state gait, potentially affecting the accuracy of some spatio-temporal parameters. Additionally, using only two cameras limits the capture of three-dimensional joint movements and may miss subtle out-of-plane motions. The sample size and participant diversity (if applicable) may also affect the generalizability of the findings. Furthermore, marker placement and manual digitization could introduce measurement errors, despite careful calibration.

FUTURE SCOPE:

Future work could expand on this setup by incorporating longer walkways and more camera views or motion capture technologies to enable comprehensive three-dimensional gait analysis. Integrating force plates and electromyography could further elucidate the relationship between joint kinematics, muscle activity, and ground reaction forces. Additionally, applying machine learning algorithms to automate deviation detection and classify gait abnormalities could enhance clinical usability. Longitudinal studies assessing intervention outcomes based on GaitOn's kinematic data would help validate its efficacy in rehabilitation planning. Finally, expanding the participant pool to include various clinical populations would broaden the applicability of the system and contribute to more personalized gait assessments.

REFERENCES:

1. Baker R, McGinley JL, Schwartz MH, Beynon S, Rozumalski A, Graham HK, & Tirosh O. The gait profile score and movement analysis profile. Gait & Posture. 2009; 30(3), 265–269. https://doi.org/10.1016/j.gaitpost.2009.05.020
2. Boudarham J, Hameau S, Pradon D, Bensmail D, Roche N. Changes in electromyographic activity after botulinum toxin injection of the rectus femoris in patients with hemiparesis walking with a stiff-knee gait. Journal of Electromyography and Kinesiology. (2013); 23(5), 1036–1043. https://doi.org/10.1016/j.jelekin.2013.05.011
3. Dietz V. Proprioception and locomotor disorders. Nature Reviews Neuroscience. 2002; 3(10), 781–790. https://doi.org/10.1038/nrn939
4. Huang HJ, Mercer VS, Gill NW. Effects of age and gait speed on lateral stability in healthy adults. Gait & Posture. 2010; 31(4), 551–555. https://doi.org/10.1016/j.gaitpost.2010.02.011
5. Ivanenko YP, Cappellini G, Dominici N, Poppele RE, Lacquaniti F. Coordination of locomotion with voluntary movements in humans. Journal of Neuroscience. 2006; 26(49), 12231–12242. https://doi.org/10.1523/JNEUROSCI.2335-06.2006
6. Lewek MD, Braun CH, Wutzke CJ, Asay JL. The role of movement history in hamstring muscle behavior during the swing phase of gait. Journal of Biomechanics. 2007; 40(15), 3555–3561. https://doi.org/10.1016/j.jbiomech.2007.05.020
7. Murtagh EM, Nichols L, Mohammed MA, Holder R, Nevill AM, Murphy MH. The effect of walking on risk factors for cardiovascular disease: An updated systematic review and meta-analysis. Preventive Medicine. 2015; 72, 34–43. https://doi.org/10.1016/j.ypmed.2014.12.041
8. Paterson DH, Warburton DER. Physical activity and functional limitations in older adults: A systematic review related to Canada's Physical Activity Guidelines. International Journal of Behavioral Nutrition and Physical Activity. 2010; 7(1), 38. https://doi.org/10.1186/1479-5868-7-38
9. Perry, J., & Burnfield, J. M. Gait analysis: Normal and pathological function. 2010; (2nd ed.). SLACK Incorporated.
10. World Health Organization. Guidelines on physical activity and sedentary behaviour. (2020); https://www.who.int/publications/i/item/9789240015128