OPEN ACCESS JOURNALS
Indiana Journal of Multidisciplinary Research
Abbreviate Tittle- Ind J Multi Res
ISSN *(Online)*- 2583-3820
Journal Homepage Link- https://indianapublications.com/Journals/IJMR
DOI: https://doi.org/10.5281/zenodo.18021199

INDIANA PUBLICATIONS
PRODUCTIVE AND QUALITY RESEARCH

Research Article

Volume-05|Issue-06|2025

Influence of Multimodal Fitness Training on Gait Parameters in Obese Male and Female Adults Using Video-Based Motion Analysis

Dr. Satish Kumar[1], Dr. Subhashis Biswas[2], Dr. Basanti Naik[3], Dr. Bidyarani Yumnam[4]

[1]Assistant Professor, Department of Physical Education & Director of sports, The ICFAI University Tripura.
[2]Assistant Professor, Department of Physical Education, The ICFAI University Tripura.
[3]HOD (Physical Education), Mayoor PVT school, Abu Dhabi, UAE.
[4]Assistant Professor, Department of Physical Education, The ICFAI University Tripura.

Article History
Received: 08.11.2025
Accepted: 15.12.2025
Published: 22.12.2025

Citation
Kumar, S., Biswas, S., Naik, B., & Yumnam. (2025). Influence of Multimodal Fitness Training on Gait Parameters in Obese Male and Female Adults Using Video-Based Motion Analysis. *Indiana Journal of Multidisciplinary Research, 5*(6), 126-132.

Abstract: The present study investigated the effects of a six-week physical fitness training programme on stride length during walking and running among obese adults aged 35-45 years from Chhattisgarh. A total of 200 male and female participants were selected, and biomechanical measurements were obtained using a repeated-measures design. Spatiotemporal walking and running parameters were captured through high-resolution video analysis using KINOVEA software (Version 0.9.5). Four YI 4K action cameras, calibrated with a 1.0 × 1.0 m iron calibration frame, were positioned to analyse sagittal-plane gait variables during specific phases of walking (mid-stance and pre-swing) and running (mid-stance, take-off, and initial swing). The intervention consisted of endurance, strength, circuit, plyometric, and speed training administered over six weeks. Descriptive statistics and repeated-measures ANOVA were applied to assess pre- and post-training stride length differences. Results demonstrated statistically significant improvements ($p < 0.01$) in stride length for both males and females during walking and running. Male stride length during walking increased from 54.68 ± 0.29 cm to 68.28 ± 0.17 cm, and female stride length increased from 43.70 ± 0.21 cm to 55.60 ± 0.28 cm. During running, males improved from 61.40 ± 0.46 cm to 77.74 ± 0.34 cm, and females from 49.60 ± 0.28 cm to 59.60 ± 0.50 cm. The findings suggest that systematic fitness training produces significant biomechanical adaptations, enhancing locomotor performance in obese adults, consistent with prior literature on neuromuscular and gait improvement following structured exercise interventions.

Keywords: Stride length, obese adults, gait biomechanics, walking and running, six-week training programme, Kinovea software, motion analysis.

INTRODUCTION

The application of biomechanics in sports, exercise science, and human movement analysis has become increasingly indispensable due to the rising demands of performance optimization and scientific precision. By replacing traditional trial-and-error coaching strategies with objective, quantifiable methods, biomechanics provides a systematic approach for analysing movement patterns, improving efficiency, and reducing the risk of fatigue and injury **(Reddy, 2015)**. Since the human body functions as a biological machine governed by mechanical laws, biomechanical assessment offers crucial insights into how internal and external forces influence motion, particularly during dynamic activities such as walking and running.

Biomechanics, a core discipline within kinesiology, is broadly categorized into kinematics describing the observable characteristics of motion and kinetics, which examines the forces responsible for movement **(Hall, 2012)**. In gait analysis, these principles are essential for evaluating stride length, segmental alignment, and joint dynamics, all of which contribute to locomotor efficiency. Technological advancements have further enhanced gait research through high-speed video capture, markerless motion analysis, and computational modelling, providing improved accuracy in measuring real-time human movement.

Recent literature underscores the growing value of advanced biomechanical tools in gait and running analysis. **Caleb D. Johnson *et al.* (2022)** demonstrated that open-source, markerless motion capture systems such as DeepLabCut can reliably estimate sagittal foot and tibia angles during running, showing excellent agreement with manual digitization. Their findings highlight the feasibility of low-cost, software-based approaches for detailed kinematic assessment. Complementing this, **Samuel E. Masters *et al.* (2022)** reported that soft tissue wobbling masses significantly influence hip joint dynamics during running, with potential implications for interpreting joint loads in inverse dynamics models. Their work emphasizes the need to account for soft tissue displacement to avoid overestimation of mechanical effort at the hip.

Footwear and its influence on joint mechanics have also been explored extensively. **Ethan Steiner *et al.* (2022)** evaluated variable stiffness shoes (VSS) in individuals with knee osteoarthritis and observed

***Corresponding Author:** Dr. Satish Kumar

alterations in rotational moments at the knee and hip, despite no significant changes in overall joint contact forces. Their results suggest that joint loading is influenced by multi-planar mechanics, further reinforcing the complexity of gait analysis. In the domain of knee joint stability, **Andrea Biscarini *et al.* (2021)** demonstrated that voluntary quadriceps–hamstring cocontraction during isometric knee exercises can increase tibiofemoral compression while unloading the anterior cruciate ligament (ACL), although anatomical variations may alter this effect. These findings contribute valuable insights for designing rehabilitation and performance training protocols.

Parallel to biomechanical efficiency, **physical fitness** forms the physiological basis for optimal movement. Physical fitness encompasses a set of measurable attributes that enable individuals to perform daily activities energetically and without undue fatigue. According to **CARL J. *et al.* (1986)**, key components of health-related fitness cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility directly influence locomotor performance and gait mechanics. In obese individuals, excess adiposity and reduced muscular strength often modify stride characteristics, leading to less efficient gait patterns.

Given this background, investigating how structured physical fitness training contributes to biomechanical improvements in gait is vital, particularly for populations with altered movement mechanics such as obese adults. Therefore, the present study examines the effects of a six-week physical fitness training programme on stride length during walking and running, using video-based sagittal-plane analysis to provide precise biomechanical measurements.

MATERIALS AND METHODS

Selection of subjects

To achieve the purpose of this study (N=100) male obese and (N=100) Female obese from Chhattisgarh state were selected on purposive basis as subjects for this study. The age of the subjects was 35 to 45 years.

Sampling design

Random Sampling design was used to select the subjects of this study. Among (N=200) male and female obese from Chhattisgarh state were selected on random basis as subjects for this study were selected as subjects.

Selection of variables

- **Independent variable**: - six-week physical fitness training
- **Dependent variables**: - stride length of obese during walking (centimeters) and stride length of obese during running (centimeters)

Research Design

Repeated-measures design was adopted by the researcher. In this study KINOVEA software (Version 0.9.5) was used to measure the biomechanical variables.

Camera procedure

Accurate assessment of walking and running mechanics is challenging when relying solely on visual observation, as coaches cannot retain individual movement frames or quantify biomechanical variables precisely. Therefore, video-based motion analysis was employed in this study. The gait performance was recorded in two walking phases **mid-stance phase of single support** and **pre-swing phase of double support II** and in three running phases **mid-stance**, **take-off**, and **initial swing**. To ensure spatial accuracy, a **camera calibration frame** constructed from iron bars in a square configuration was used. The calibration cage measured **1.0 × 1.0 meters** and included four control points to standardize the capture volume in which the subjects performed. All cameras were positioned **5 meters** from the plane of motion at a height of **1.0 meter** to obtain optimal sagittal-plane footage for biomechanical analysis.

Kinovea Software (Version -0.9.5)

Free software called Kinovea was used to analyse videos. For instance, coaches and athletes use Kinovea to fine-tune approaches. With the help of Kinovea, it is able to measure height, speed, and distance on a specific video. We are able to visually navigate the video collection using the integrated file explorer.

Cumulative Day-Wise Training Description (Six Weeks)

1. **Monday – Endurance Training:** Across all six weeks, Monday was consistently dedicated to endurance development through slow continuous running. Participants performed 25 minutes of continuous running during Weeks 1 and 2, which increased progressively to 30 minutes in Weeks 3 and 4, and further to 35 minutes in Weeks 5 and 6. From Week 3 onward, Running ABC drills were incorporated to improve neuromuscular coordination, stride mechanics, and running efficiency. The progressive increase in duration ensured a gradual enhancement of aerobic capacity and overall stamina.
2. **Tuesday – Weight Training:**- Tuesdays focused on strength development through weight training, targeting both the upper and lower body. Each session consisted of five exercises performed at 60% of the individual's training load. During Weeks 1 and 2, the protocol involved 3 sets of 12 repetitions. The volume increased in Weeks 3 and 4 to 3 sets of 14 repetitions, and further to 3 sets of 16 repetitions in Weeks 5 and 6. This systematic progression promoted muscular strength, endurance, and neuromuscular adaptation while maintaining moderate intensity for safe overload.

***Corresponding Author:** Dr. Satish Kumar

3. **Wednesday – Speed Training:** Speed development was emphasized every Wednesday using short-distance repeated sprints. Participants performed 30 meters × 5 sets × 5 repetitions at 60% intensity during Weeks 1 and 2. This distance increased to 35 meters in Weeks 3 and 4, and to 40 meters in Weeks 5 and 6, while maintaining the same number of sets and repetitions. The gradual increase in sprint distance facilitated improvement in acceleration, stride length, stride frequency, and overall speed mechanics while preventing excessive fatigue.
4. **Thursday – Endurance Training (With Running Drills):-** Thursday sessions mirrored Monday but consistently included Running ABC drills across all weeks. In Weeks 1 and 2, participants completed 25 minutes of slow continuous running followed by technique drills. The duration increased to 30 minutes in Weeks 3 and 4 and further to 35 minutes in Weeks 5 and 6. The combination of endurance running and technical drills supported improvements in cardiovascular fitness, running form, and movement efficiency.
5. **Friday – Plyometric Training:-** Fridays were dedicated to plyometric conditioning focused on enhancing explosive power. Across all six weeks, the sessions consisted of box jumps and hurdle drills. These plyometric exercises targeted the stretch-shortening cycle, improved ground reaction forces, increased lower-limb power output, and enhanced dynamic coordination. The training load remained consistent weekly to maintain safety and prevent overuse injuries while reinforcing neuromuscular responsiveness.
6. **Saturday – Circuit Training:-** Circuit training was performed every Saturday using a bootcamp-style format. The activities included tyre drills, battle rope exercises, and cross-fit drills, engaging multiple muscle groups and energy systems. This multimodal training approach promoted muscular endurance, agility, anaerobic conditioning, and metabolic efficiency. The structure remained constant across all six weeks, ensuring repeated exposure for skill mastery and conditioning benefits.
7. **Sunday – Rest Day:-** Sunday served as the designated recovery day during Week 1, allowing physiological restoration. Although not explicitly mentioned for Weeks 2 to 6, rest is inherently necessary in any structured training program, supporting muscle repair, adaptation, and prevention of overtraining.

TEST ADMINISTRATION

The following tests were administered to measure the selected biomechanical variables.

Selections of test

1. **Stride length of obese during walking (centimeters).**

Purpose: To measure the Stride length of obese during walking.

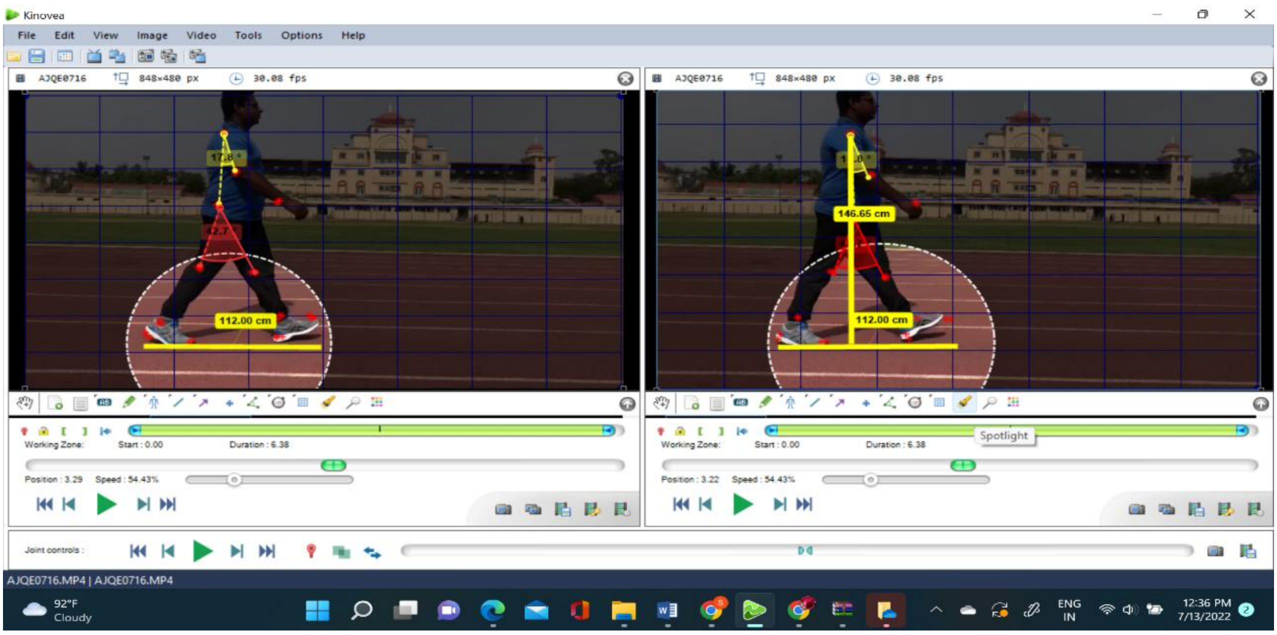

Figure 1: Showing the stride length of obese during walking (centimeters).

2. **Stride length of obese during running (centimeters).**

Purpose:- To measure the Stride length of obese during running.

***Corresponding Author:** Dr. Satish Kumar

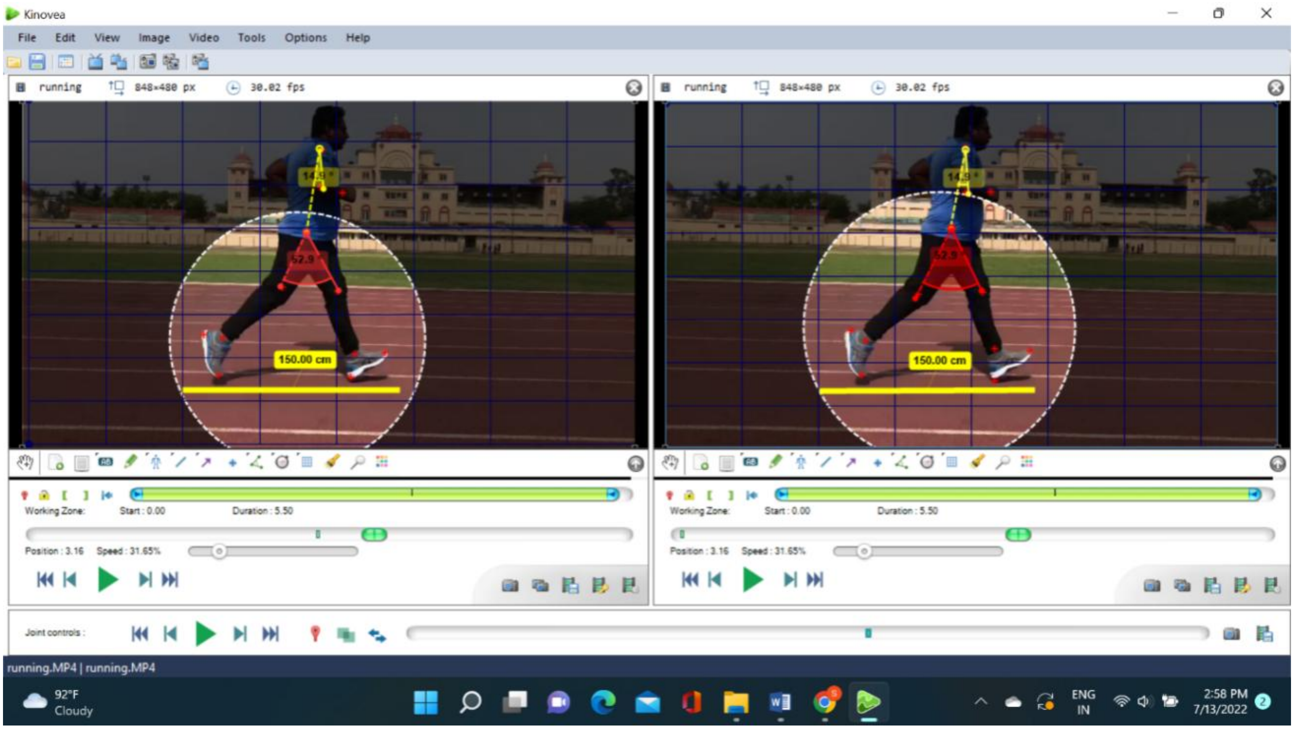

Figure 2: Showing the Stride length of obese during running (centimetres).

Compilation of Data

The data pertaining to the study were collected by administering the appropriate tools for the selected variables. The data were collected in the prescribed proforma made for this purpose. After collection they were entered in Microsoft Excel for further processing.

Statistical Procedure

The data were analyzed by using Descriptive (Mean ± SE) and inferential (ANOVA) statistics was employed to analyse the data obtained from the subjects.For this the research scholar used the Micro-Soft Excel and SPSS statistical tool to analyze the data.

RESULTS AND DISCUSSION

Table 1: Showing the comparison of stride length during walking between pre and post test of male and female

Gender	Pre Test		Post Test		ANOVA	
	Mean ± SE	SD	Mean ± SE	SD	F-value	P-value
Male	54.68 ± 0.29	2.97	68.28 ± 0.17	1.74	1553.88	p<0.01
Female	43.7 ± 0.21	2.17	55.6 ± 0.28	2.89	1078.41	p<0.01

The results show significant improvements in performance from pre-test to post-test for both male and female participants. Among males, the pre-test mean score was **54.68 ± 0.29**, which increased to **68.28 ± 0.17** in the post-test. This substantial improvement is reflected in the high **F-value of 1553.88**, with a **p-value < 0.01**, indicating that the training intervention produced a statistically significant effect on male participants. Similarly, females demonstrated notable improvement, with their pre-test mean score increasing from **43.70 ± 0.21** to **55.60 ± 0.28** in the post-test. The corresponding **F-value of 1078.41**, along with a **p-value < 0.01**, confirms a highly significant improvement following the training program. Although both groups improved significantly, males showed a slightly higher absolute gain compared to females.

***Corresponding Author:** Dr. Satish Kumar

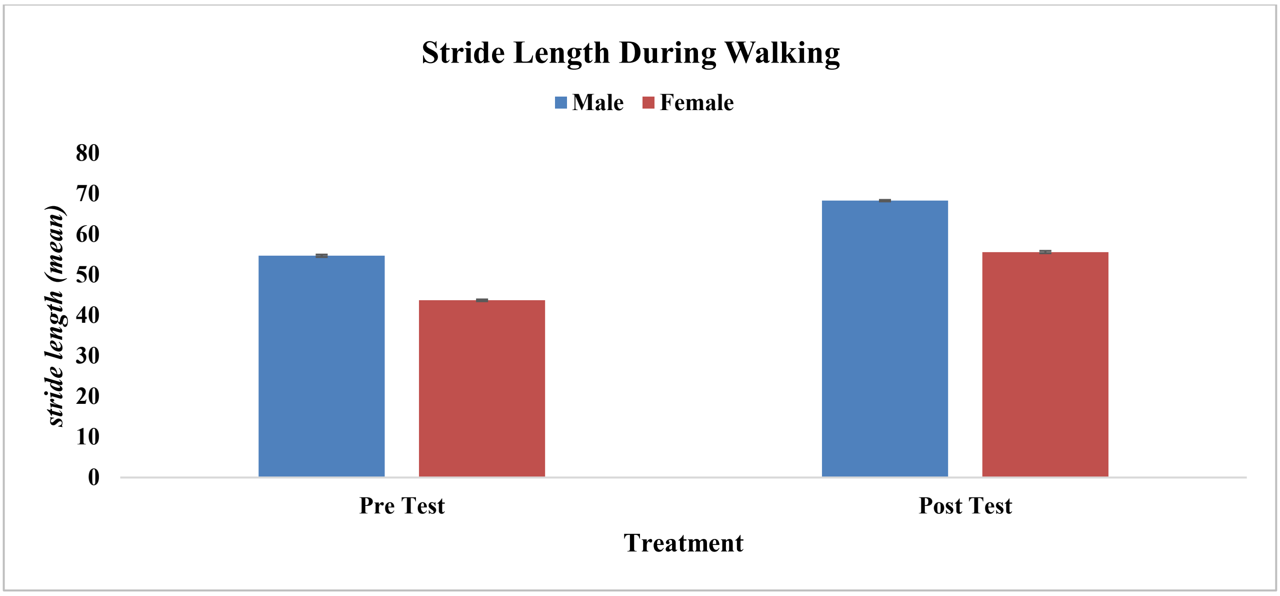

Figure 3: Showing the comparison of stride length during walking before and after training of obese male and female subjects.

Table 2: Showing the comparison of Stride Length during Running between pre and post test

Gender	Pre Test		Post Test		ANOVA	
	Mean ± SE	SD	Mean ± SE	SD	F-value	P-value
Male	61.40 ± 0.46	4.67	77.74 ± 0.34	3.4	797.383	$p<0.01$
Female	49.60 ± 0.28	2.89	59.60 ± 0.50	5.07	292.899	$p<0.01$

The results clearly demonstrate a significant improvement in performance for both male and female participants following the training intervention. Among males, the mean score increased from **61.40 ± 0.46** in the pre-test to **77.74 ± 0.34** in the post-test, with reduced variability indicating more consistent performance. The very high **F-value of 797.383** and **p < 0.01** confirm that this improvement is statistically meaningful. Similarly, females showed progress, with mean scores rising from **49.60 ± 0.28** to **59.60 ± 0.50**, and the corresponding **F-value of 292.899** and **p < 0.01** indicating strong statistical significance. These findings collectively suggest that the training program produced substantial and reliable gains in performance across genders, with the magnitude of improvement being greater in males.

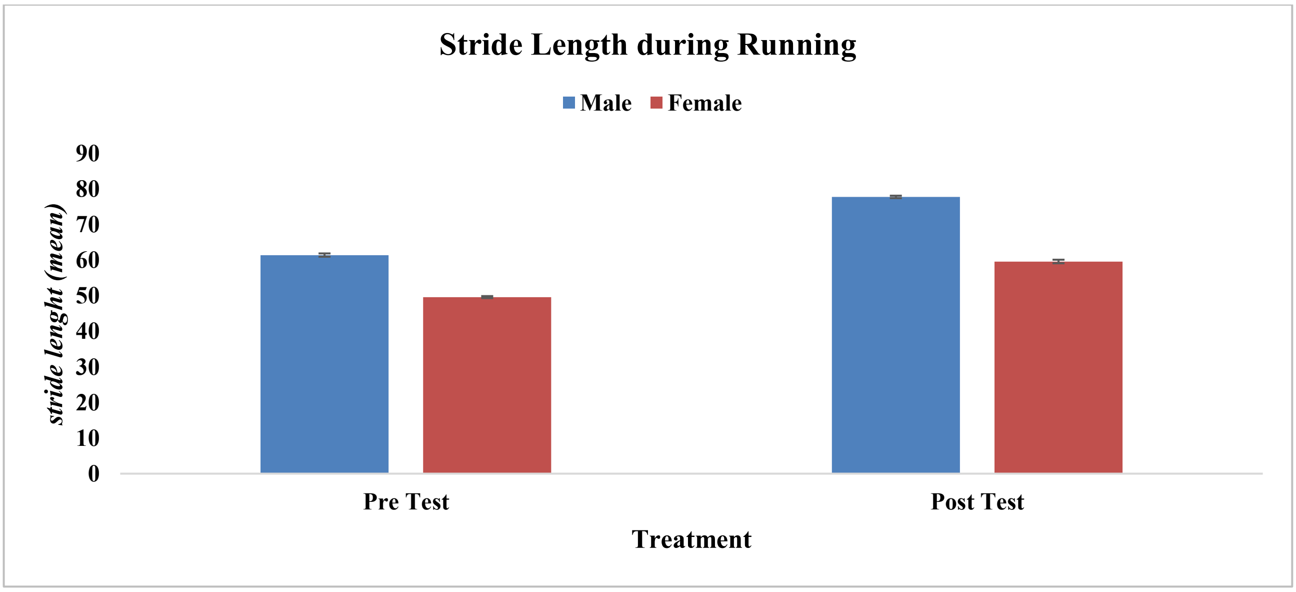

Figure 4: Showing the comparison of Stride Length during Running before and after training of obese male and female subjects.

***Corresponding Author:** Dr. Satish Kumar

DISCUSSION

The findings of the present study provide clear evidence that a structured six-week training program brought about significant improvements in stride length during both walking and running among obese male and female participants. The substantial increase in stride length observed in the post-test measurements reflects enhanced lower-limb function, improved neuromuscular coordination, and increased propulsion efficiency changes commonly associated with regular endurance, strength, and plyometric training **(Carl J. *et al.*, 1986).** The marked improvements in males and females during walking, as demonstrated by large F-values **(1553.88 for males and 1078.41 for females)**, indicate that the intervention effectively enhanced gait mechanics across genders. These gains may be attributed to improved muscular strength, flexibility, and better control of the lower extremities, which collectively contribute to longer and more efficient walking strides.

Similarly, the results for running stride length show significant enhancement following the training program. Male participants exhibited a pronounced increase from pre- to post-test, with an **F-value of 797.383**, while females also demonstrated meaningful improvement, supported by an **F-value of 292.899**. The gender differences observed where males displayed a slightly greater absolute improvement may be related to baseline strength differences, variations in muscle mass, or differing responses to training stimuli, as documented in previous biomechanical research. Nonetheless, the improvements in both groups affirm that the integrated training regimen effectively targeted the biomechanical determinants of stride mechanics.

Overall, the results align with established literature indicating that combined endurance, strength, speed, and plyometric training enhances gait parameters by improving force production, reducing muscular fatigue, and promoting efficient movement patterns. The positive adaptations in stride length suggest meaningful functional benefits for obese individuals, potentially contributing to improved mobility, reduced injury risk, and enhanced overall physical performance.

CONCLUSION

The study concludes that a systematically designed six-week physical fitness training program produces significant and meaningful improvements in stride length during both walking and running among obese adults aged 35-45 years. The post-training enhancements observed across male and female participants reflect positive adaptations in lower-limb strength, neuromuscular coordination, and gait efficiency mechanisms consistently supported in biomechanical and exercise-training literature (e.g., Carl *et al.*, 1986).

Both genders demonstrated substantial gains, as evidenced by statistically large F-values in walking and running measures, indicating that the intervention effectively enhanced spatiotemporal gait parameters irrespective of sex. Although males showed slightly greater improvements, likely due to baseline physiological differences, the intervention proved beneficial for all participants.

These findings suggest that an integrated fitness regimen combining endurance, strength, speed, and plyometric elements can meaningfully improve functional mobility and biomechanical efficiency in obese adults. Such adaptations may contribute to better movement economy, reduced risk of musculoskeletal strain, and overall improved physical performance. The study highlights the importance of structured training programs in promoting healthy gait patterns and supporting long-term functional well-being in obese populations.

REFERENCES

3. Ahalee, C. F., & Palmer, T. B. (2021). Age-related differences in hip flexion maximal and rapid strength and rectus femoris muscle size and composition. *Journal of Applied Biomechanics, 37*(4), 311–319.
4. Allison, H. G., Zhang, S., Pan, J., & Li, L. (2021). Leg and joint stiffness adaptations to minimalist and maximalist running shoes. *Journal of Applied Biomechanics, 37*(5), 408–414.
5. Biscarini, A., Panichi, R., Dieni, C. V., & Contemori, S. (2021). Effects of voluntary quadriceps–hamstring cocontraction on tibiofemoral force during isometric knee extension and knee flexion exercises with constant external resistance. *Journal of Applied Biomechanics, 37*(6), 565–572.
6. Chinnappa Reddy, P. (2015). *Scientific principles of biomechanics*. Friends Publication.
7. Gordon, D., Robertson, E., Caldwell, G. E., Hamill, J., Kamen, G., Saunders, N., & Whittlesey, S. (2004). *Research methods in biomechanics*. Human Kinetics.
8. Hrangkhawl, M. S., & Kumar, S. (2025). Kinematic analysis of approach run and take-off in national-level female vaulting athletes. *International Journal of Creative Research Thoughts, 13*(11), e818–e828. https://doi.org/10.56975/ijcrt.v13i11.296975
9. Jeny, N., Kumar, S., Devi, S. S., & Chanu, O. W. (2025). Biomechanical analysis of standing long jump of junior national football girls with the implementation of general warming up and RAMP warm-up. *Indiana Journal of Agriculture and Life Sciences*, 163–167. https://doi.org/10.5281/zenodo.17231812
10. Kumar, S., & Singh, A. K. (2022). The effects of fitness training on the kinematical variables of obese people during running. *Nagfani Journal, 12*(41), 72–77.

***Corresponding Author:** Dr. Satish Kumar

11. Langley, B., Cramp, M., & Morrison, S. C. (2019). The influence of motion control, neutral, and cushioned running shoes on lower limb kinematics. *Journal of Applied Biomechanics, 35*(3), 216–222.

12. Unver, B., Selici, K., Akbas, E., & Erdem, E. U. (2021). Foot posture, muscle strength, range of motion, and plantar sensation in overweight and obese individuals. *Journal of Applied Biomechanics, 37*(2), 87–94.

***Corresponding Author:** Dr. Satish Kumar